BNL 17874

1972 ENVIRONMENTAL MONITORING REPORT

BROOKHAVEN NATIONAL LABORATORY
Upton, New York 11973

Operated by Associated Universities, Inc.
Under Contract to the U.S. Atomic Energy Commission

May, 1973

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BROOKHAVEN NATIONAL LABORATORY

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INTRODUCTION

Brookhaven National Laboratory is a scientific research center situated in Suffolk County on Long Island, about 70 miles east of New York City. Its location with regard to surrounding communities is shown in Fig. 1. The largest populations are located in shoreline communities, although the land area within ten miles is mostly either forested or under cultivation. Considerable recent and projected development of suburban housing is located within this area.

The Laboratory site with its principal effluent-producing facilities is shown in Fig. 2. It consists of some 5,265 acres, most of which is wooded, except for a central area of less than 1,000 acres. The site terrain is gently rolling, with elevations varying between 120 and 40 feet above sea level. The land lies on the west rim of the shallow Peconic River watershed, with the river itself rising in marshy areas in the north and east sections of the site.

A wide variety of scientific programs are conducted at Brookhaven, including research or development in the following areas:

1) Structure and properties of matter.
2) Physical, chemical and biological effects of radiation.
3) Radioisotopes and other nuclear tools.
4) Nuclear technology.

Among the major scientific facilites operated at Brookhaven to carry out the above programs are:

1) The High Flux Beam Reactor (HFBR). It is fueled with enriched uranium, heavy water moderated and cooled, and has a routine power level of 40 MW.

2) The Medical Research Reactor (MRR), which is an integral part of the Medical Research Center. It is enriched uranium fueled, natural water moderated and cooled, and is operated intermittently at power levels up to 3 MW.

3) The Alternating Gradient Synchrotron (AGS), a proton accelerator which operates at energies up to 33 BeV.

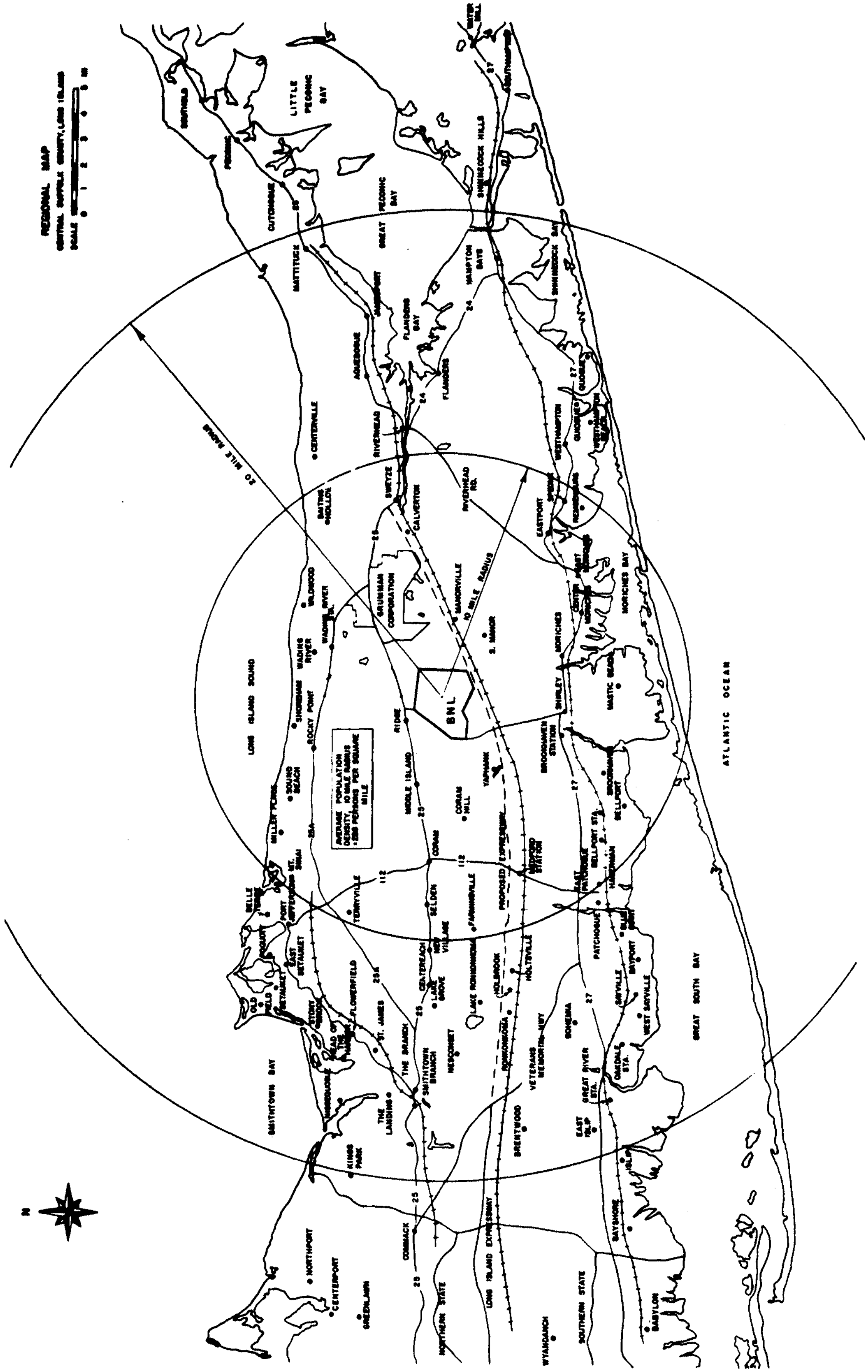

REGIONAL MAP
CENTRAL SUFFOLK COUNTY, LONG ISLAND
LONG ISLAND SOUND
ATLANTIC OCEAN
GREAT SOUTH BAY
SMITHTOWN BAY
GREAT PECONIC BAY
LITTLE PECONIC BAY
FLANDERS BAY
MORICHES BAY
SHINNECOCK BAY
BNL
10 MILE RADIUS
20 MILE RADIUS
AVERAGE POPULATION DENSITY, 10 MILE RADIUS
GRUMMAN CORPORATION
LONG ISLAND EXPRESSWAY
PROPOSED EXPRESSWAY
VETERANS MEMORIAL HWY
NORTHERN STATE
SOUTHERN STATE
RIVERHEAD
CALVERTON
MANORVILLE
S. MANOR
RIDGE
ROCKY POINT
SHOREHAM
WADING RIVER
MIDDLE ISLAND
CORAM
YAPHANK
SHIRLEY
MORICHES
BROOKHAVEN STATION
EASTPORT
WESTHAMPTON
HAMPTON BAYS
PATCHOGUE
HOLBROOK
SMITHTOWN BRANCH
NORTHPORT
CENTERPORT
COMMACK
BABYLON
BAYSHORE
WYANDANCH
MATTITUCK
CUTCHOGUE
AQUEBOGUE
FLANDERS
TERRYVILLE
SELDEN
FARMINGVILLE
BRENTWOOD
SAYVILLE
WEST SAYVILLE
BELLPORT
MASTIC BEACH

FIGURE 1

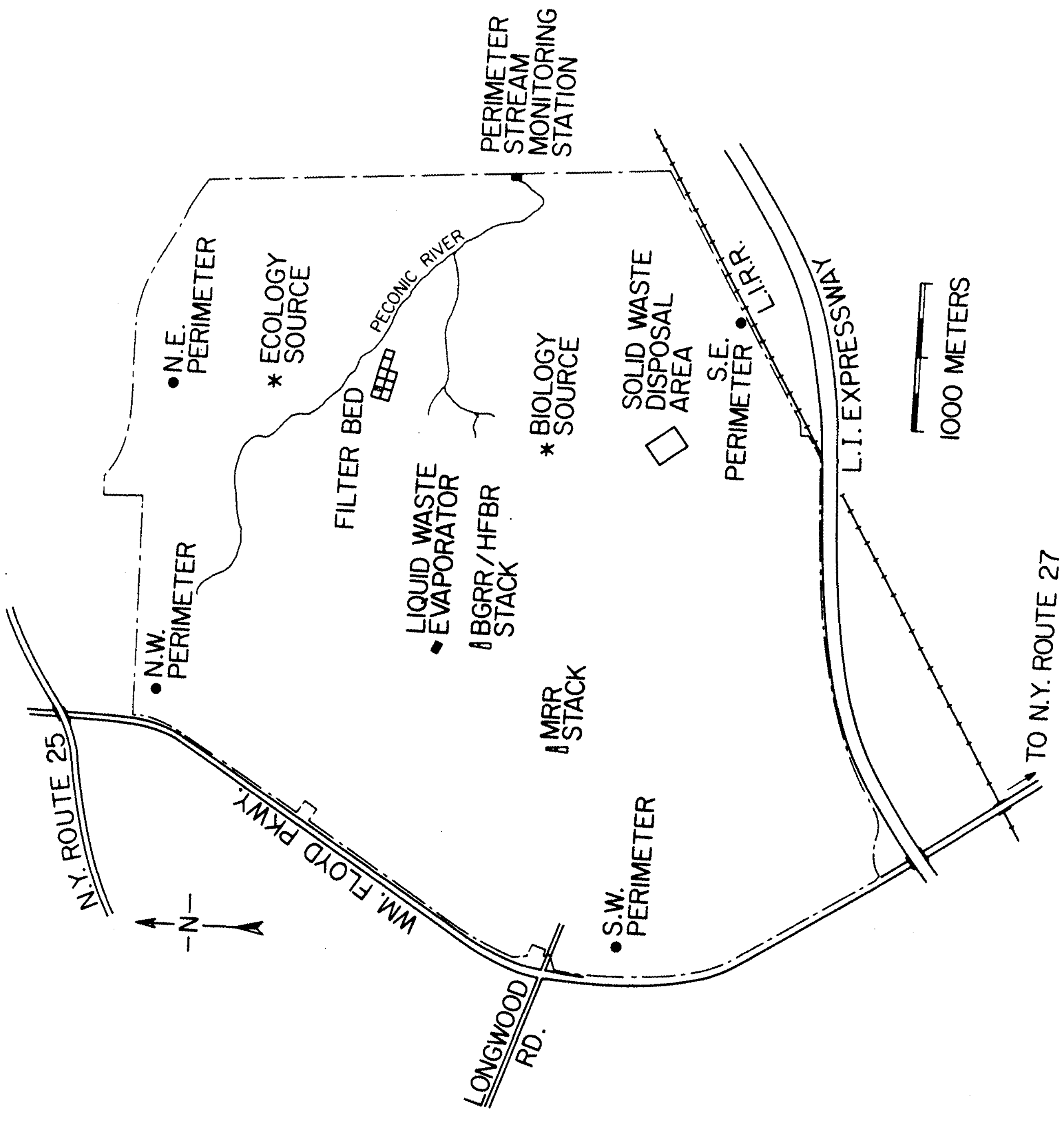

PERIMETER
STREAM
MONITORING
STATION
N.E.
PERIMETER
ECOLOGY
SOURCE
PECONIC RIVER
FILTER BED
LIQUID WASTE
EVAPORATOR
BGRR/HFBR
STACK
BIOLOGY
SOURCE
SOLID WASTE
DISPOSAL
AREA
S.E.
PERIMETER
L.I.R.R.
L.I. EXPRESSWAY
1000 METERS
N.W.
PERIMETER
MRR
STACK
S.W.
PERIMETER
TO N.Y. ROUTE 27
N.Y. ROUTE 25
WM. FLOYD PKWY.
LONGWOOD
RD.
N

FIGURE 2

4) The 200 MeV Proton Linac, which serves as an injector for the AGS, but also supplies continuous currents of protons for isotope production by spallation reactions.

5) The Tandem Van de Graaff, 60-inch Cyclotron, Research Van de Graaff, Vertical Accelerator and Chemistry Van de Graaff, which are used in medium energy physics investigations, as well as for special isotope production.

6) The High Intensity Radiation Development Laboratory (HIRDL), which contains million-curie range ^{60}Co and ^{137}Cs sources, and is used for source development and experimental process irradiations.

Additional programs involving irradiations and/or the use of radionuclides for scientific investigations are carried on at other Laboratory facilities, including the Medical Research Center, the Biology Department (including two multi-curie field irradiation sources), the Chemistry Department, and the Department of Applied Science. The latter includes the Hot Laboratory, where special purpose radioisotopes are developed and processed for on and off-site use.

Most of the airborne radioactive effluents at Brookhaven originate from the HFBR, the MRR and the Research Van de Graaff, with lesser contributions from the Chemistry and Medical Research Centers. The first two also produce significant fractions of the Laboratory's liquid radioactive effluents, but additional significant contributions originate from the Medical Research Center, the Hot Laboratory complex, as well as from decontamination and hot laundry operations.

SUMMARY

Natural background and radiation levels in the vicinity of Brookhaven National Laboratory attributable to its operations during 1972 are summarized in this report. Among the data reported are external radiation levels; air particulate, tritium and radioiodine concentrations; precipitation and liquid effluent-related concentrations in stream, ground water and surveillance wells, as well as in milk, grass and soil samples.

External radiation levels at the north boundary of the Laboratory, attributable to an ecology forest irradiation source, were 15.6 mrem/yr, or 3.1% of the applicable radiation protection standard[(1)]. Other than tritium, there was no indication of BNL effluents in environmental air and precipitation samples. In air, the largest BNL effluent-related tritium concentration was 4×10^{-12} μCi/ml which is 0.002% of the applicable standard. In precipitation it was 2.77×10^{-4} μCi/ml, which is 0.01% of the standard for drinking water.

About 83% of the volume of liquid effluent released onto the sand filter beds at the BNL sewage treatment plant was recovered and flowed into the headwaters of the Peconic River, while about 17% of it flowed into the ground water underlying the beds. The gross concentration of beta and gamma-emitters in it was 1.9% of the applicable radiation standard. Tritium, which is measured separately, was 0.13% of its standard.

Of the combined flow from the sand filter beds to the Peconic River and that above the outfall, 45% permeated into the ground water underlying the stream bed between the point of release and the Laboratory perimeter, while 55% flowed over the measuring weir at the boundary. The gross beta and gamma emitter concentration at the site boundary was 1.7% of the applicable radiation protection standard, while that of tritium was 0.10% of its standard.

The water released into the Peconic from the Liquid Effluent Treatment Facility was well within the standards for drinking water quality established by the New York State Department of Health[(2)].

At downstream locations, the largest yearly average gross beta concentration in monthly grab samples was 0.5% of the applicable radiation protection standard, while that of tritium was 0.03% of its standard. The downstream gross beta concentrations were only slightly above those measured at remote "control" stream locations.

Seasonal sampling of Peconic River bottom sediments, stream vegetation and of miscellaneous aquatic fauna indicated that small concentrations of ^{60}Co ($< 10^{-6}$ μCi/gm), and a slight increase ($< 3 \times 10^{-6}$ μCi/gm) of ^{137}Cs above prevailing fallout background, were present in some samples obtained in the upper reaches of the Peconic, on-site and a few miles downstream. These concentrations are insignificant (< 1%) relative to calculated concentration guides.

Routine grab samples from the Laboratory's potable and cooling water supply wells, most of which are screened at a depth of from 100 to 150 feet or about 50 to 100 feet into the water table, disclosed no significant differences between those upstream in ground water flow and those downstream from the principal Laboratory facilities. The gross beta concentration of the large volume of cooling water released to on-site sumps was only very slightly increased above that of the supply wells.

Ground water surveillance was conducted in shallow sampling wells installed adjacent to identified areas from which there is a potential for the migration of radioactivity. Immediately adjacent to the sand filter beds and the Peconic River on-site, gross alpha, gross beta, strontium and tritium concentrations up to a few percent of the applicable radiation protection standards were found.

On-site in wells adjacent to a decontamination facility drain sump, and adjacent to the Solid Waste Disposal Area, a few gross beta, ^{90}Sr and ^{137}Cs concentrations were found in excess of off-site radiation protection standards.

However, these appear to be very local, and concentrations in perimeter wells were either only a few percent of the standards, or at background levels.

Although indications were found of the presence of some contaminants in concentrations above background in a few wells adjacent to the sand filter beds and the Solid Waste Disposal Area, all measured quality indications were well within the standards[3] for ground water established by the New York State Department of Environmental Conservation.

Quarterly milk samples were obtained from two nearby dairy farms. No significant differences between ^{137}Cs levels in these and those generally prevailing in the northeast United States were apparent. During the winter and spring quarters of 1972, the levels of ^{90}Sr in milk from these farms were also typical of those in the northeast. The reported third and fourth quarter levels of ^{90}Sr in the milk from one of these nearby farms were about twice the generally prevailing New York State background and at the upper range of any reported nationwide during this period. However, there is no plausible connection between these levels and Laboratory effluents.

Two sets of grass and soil samples were also collected from these and three other farms, as well as from perimeter and on-site locations. There was no significant difference between off-site samples generally downwind and those generally upwind of Brookhaven. A possible small amount of ^{137}Cs was apparent at the BNL northeast perimeter and adjacent to the Solid Waste Disposal Area, compared to other samples.

MONITORING DATA COLLECTION, ANALYSIS AND EVALUATION

External Exposure Monitoring

External radiation levels, including natural background (as influenced by fallout) and increments attributable to BNL activity were measured continuously at the four perimeter stations shown on Fig. 2. Included in each station's equipment was an ion chamber and dynamic condensor electrometer. Those units are capable of accurately measuring < 10 μR/hr and of detecting changes of the order of 1 μR/hr.

The observed monthly average radiation levels are set forth in Table I. There was no increment to the natural background attributable to BNL activities, except at the northeast perimeter. At this location, the Ecology Forest irradiation source, which contained about 6,900 curies of ^{137}Cs, produced a radiation level of 15.6 mrem/yr, or 3.1% of the radiation protection standard[(1)] for a hypothetical individual at this location. Since the measuring station was located about 250 meters south of the present BNL north perimeter, the observed readings at that location were adjusted on the basis of spot comparisons, which indicated an average ratio of 0.2 between the station and the actual north perimeter radiation levels.

Ground-Level Air Particulate, Tritium and Radioiodine

During 1972, "high volume" (500 l/min) positive displacement air pumps (Gast 3040) were operated at a monitoring station immediately east of the Solid Waste Disposal Area, and at the north and southwest perimeter monitoring stations (Fig. 2). The air sampling media consisted of a 3-inch diameter air particulate filter (Gelman Type G) followed by a 3" x 1" bed of petroleum-based charcoal (Columbia Grade LC 12/28 x mesh) for sampling of radiohalogens. Short term fluctuations in air particulate concentrations may be indicative of the presence of recent weapons test debris. Accordingly, the Solid Waste Disposal Area air particulate filter was changed and counted on a daily (5 times per week) basis. The remaining samples were changed and counted on a two-week basis.

After allowing several days for the decay of short-lived natural radioactivity, gross alpha counts of the one-day air particulate samples (from the Solid Waste Disposal Area stations) were made using a 5" diameter Zn-S coated photomultiplier. After a similar delay, gross beta counts were made of all air particulate samples, using a 5" beta scintillator. These data are shown in Table II. No consistent differences between sampling locations were apparent and there was no indication of BNL effluent radionuclides in air particulate samples at any location.

Continuous tritium vapor collections, using thermo-electric coolers, were made seasonally at the southwest or northeast perimeter stations which were most frequently downwind from the High Flux Beam Reactor stack. These collections were composited on a monthly basis, and after enrichment by electrolysis, were assayed for tritium. Concentrations of tritium vapor above background in air at the BNL perimeter were assumed to be principally attributable to HFBR stack effluent tritium vapor, which totaled 602 curies during 1972. These were arrived at by subtracting the tritium concentrations found in an off-site precipitation collection from those found at the perimeter. The result was converted to an air concentration by assuming that 10^{-6} μCi/ml in vapor corresponds on the average to 10^{-11} μCi/cm^3 in air. This is strictly so only at 59° F and 50% R.H. These air concentration data are shown in Table III. The average net concentrations, 3×10^{-12} μCi/ml from January through June at the southwest perimeter, and 4×10^{-12} μCi/ml from July through December at the northeast perimeter, were less than 0.01% of the radiation concentration guide[1].

In addition to the gross beta counts indicated above, analyses for gamma-emitting nuclides were performed on a consolidated monthly composite of all individual air particulate samples shortly after the end of each month. Additional air particulate analyses were also scheduled at six-month and one-year post-collection to facilitate the resolution of short- and long-lived nuclides with photopeaks too close to be resolved by the NaI detection system employed. The charcoal samples were reanalyzed at one month post-collection to determine ^{131}I by decay in its photopeak region during this time. Available data are reported herein in Table IV. In the absence of any recent fission products during most of the year, all transactions in its energy region have been attributed to 285-day ^{144}Ce. These data did not disclose any indication of BNL effluent components.

Precipitation

Two pot-type rain collectors, each with a surface area of 0.33 m^2, were situated adjacent to the BNL filter beds. Two routine collections were made from these, one whenever precipitation was observed during a previous 24-hour (or weekend) period, and the other once a week whether or not precipitation had occurred. Part of each collection was evaporated for gross beta counting, a small fraction composited for monthly tritium analysis, and the balance put through ion exchange columns for subsequent monthly ^{89}Sr-^{90}Sr and gamma analyses. The data are reported in Table V.

With the exception of tritium, there is no indication in the on-site precipitation collection of the washout of BNL released airborne radioactivity. As indicated in Table VI, the ^{3}H concentration in the collector located at the filter beds (which are in a predominant downwind direction) appears to have been almost twice that of the off-site collection. It was less than 0.01% of the radiation concentration guide for drinking water. The total deposition of ^{3}H on the BNL site (about 4,000 acres) during 1971 was between 3.2 and 5.6 curies. The lower estimate is based on the concentration in the off-site collection, and the upper on that in the on-site downwind sample.

Liquid Effluent Monitoring

Within established administrative limits, small amounts of low-level radioactive liquid effluents may be routinely disposed of by release into the

Laboratory's sanitary waste system. This system affords considerable dilution by a large volume (~ 10^6 gal/day) of predominantly uncontaminated water. Primary treatment to remove suspended solids from the liquid effluents discharged to this system was provided by a 250,000 gallon Clarifier. The liquid effluent then flowed onto sand filter beds, from which most if was recovered by an underlying tile field. It was then chlorinated and released into a small stream that formed one of the headwaters of the Peconic River.

A schematic illustration of the sewage treatment plant, including the related monitoring arrangements, is shown in Fig. 3. In addition to the in-plant flow measurement and sampling instrumentation, totalizing flowmeters (Leopold & Stevens TF 61-2), which include provision for actuating a sampler with each 2,000 gallons of flow in combination with a positive-action battery-operated sampler (Brailsford DU-1), were located at the Chlorine House, at the former site boundary 0.5 miles downstream on the Peconic, and at the site boundary (1.6 miles downstream).

The monthly average flow and the monthly totals of gross beta and principal nuclide activities at the Clarifier (input to the filter beds) and at the Chlorine House (output from the beds) are shown in Table VII. Yearly totals and average concentrations are also indicated. It is apparent that not all of the liquid effluent flow into the sand filter beds appears in the output from them. The balance is assumed to mix with the ground water flow under the beds. Estimates of the amounts of radioactivity released to the ground water in this fashion during 1972 are also shown in Table VII. These were calculated on the assumption that the average concentrations of the contained nuclides corresponded to those in the observed output from the beds.

Flow, activity and concentration information at the former site boundary and at the present site boundary are shown in Table VIII-A. A greater stream flow was observed at the former site boundary than at the Chlorine House, reflecting the upstream addition to the BNL stream effluent, which during 1972

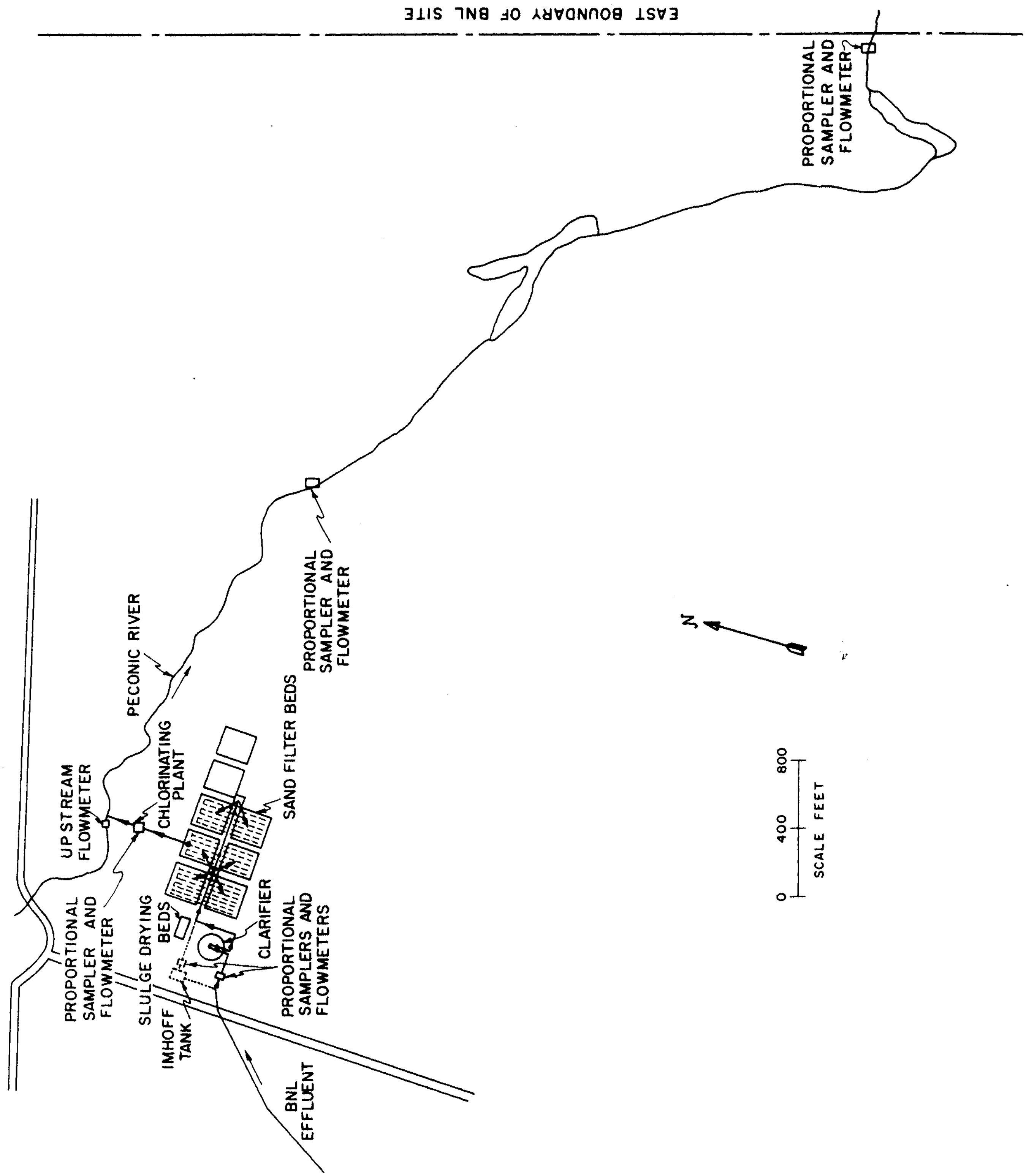
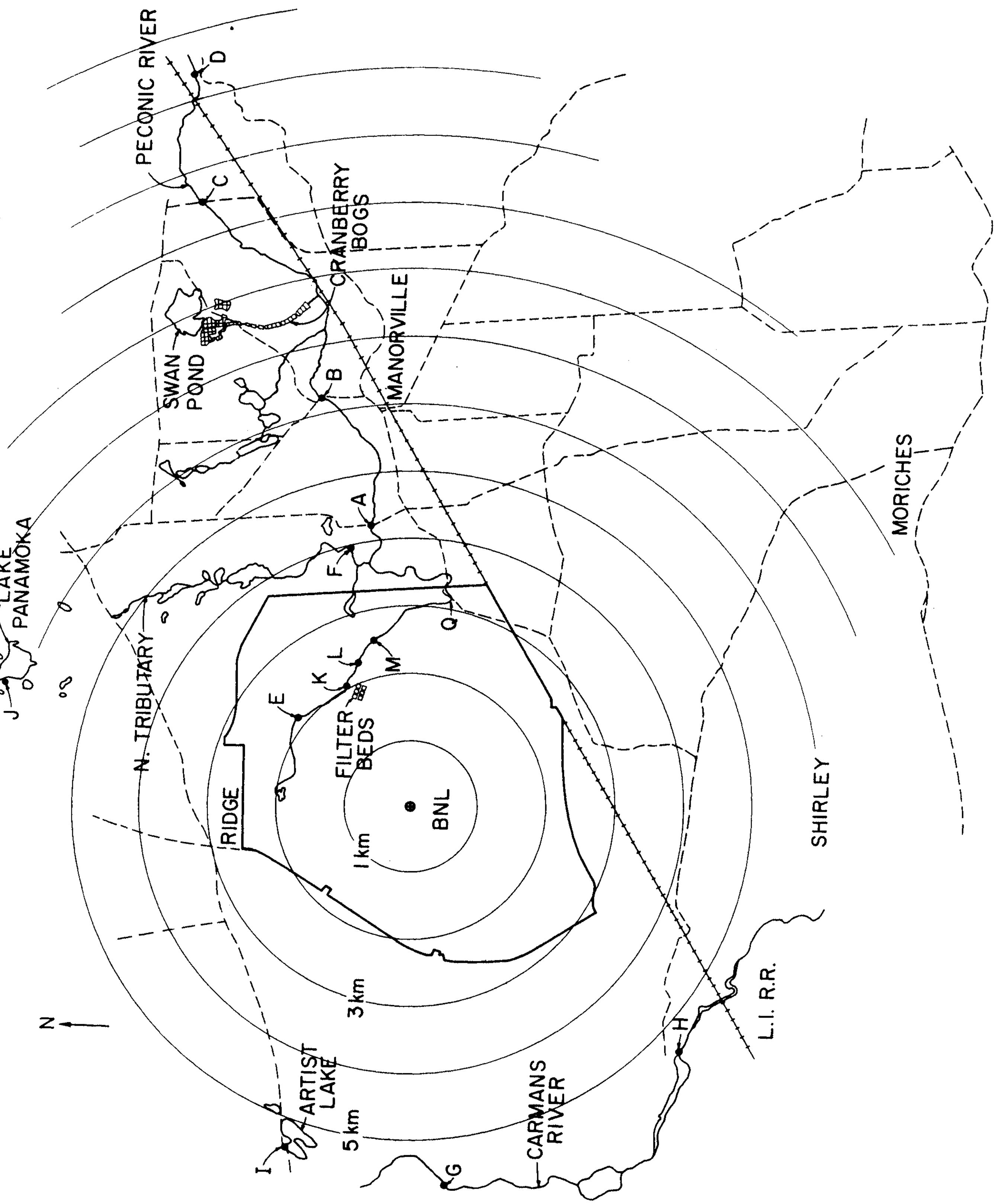

EAST BOUNDARY OF BNL SITE
PROPORTIONAL SAMPLER AND FLOWMETER
PROPORTIONAL SAMPLER AND FLOWMETER
PECONIC RIVER
N
UPSTREAM FLOWMETER
CHLORINATING PLANT
SAND FILTER BEDS
PROPORTIONAL SAMPLER AND FLOWMETER
SLULGE DRYING BEDS
CLARIFIER
PROPORTIONAL SAMPLERS AND FLOWMETERS
IMHOFF TANK
BNL EFFLUENT
0
400
800
SCALE FEET

FIGURE 3



PECONIC RIVER
D
C
CRANBERRY BOGS
MANORVILLE
SWAN POND
B
A
LAKE PANAMOKA
J
F
N. TRIBUTARY
Q
L
M
K
E
FILTER BEDS
RIDGE
BNL
1 km
3 km
5 km
SHIRLEY
MORICHES
N
ARTIST LAKE
I
CARMANS RIVER
G
H
L.I. R.R.

FIGURE 4

averaged 140,000 gallons per day. There is a negligible change in the total activity in the stream between these two locations. However, there was a considerable reduction in stream flow between the former perimeter and the present site boundary. Upper limit estimates of the total activity which may in this manner have infiltrated into the underlying ground water are also shown in Table VIII-A. These are based on the concentrations observed at the site boundary.

Analysis of monthly composite samples of the outflowing effluent streams at the Chlorine House and at the perimeter showed that on the average, 16% of the activity consisted of strontium-90 and that no appreciable amounts of long half-life radioactive iodine or bone-seeking nuclides such as radium were present. Under these circumstances, the applicable radiation concentration guide[1] was 1.23×10^{-6} µCi/ml. The observed gross beta concentration in the BNL effluent stream infiltrating to ground water or released downstream in the Peconic River was 1.8% of this guide.

The purity of the outflow from the sand filter beds into the Peconic River (as shown in Table VIII-B) was within water quality standards established for drinking water by the New York State Department of Health[2].

Monthly "grab" water samples were obtained at on- and off-site locations along the upper tributary of the Peconic River, into which the Laboratory routinely discharges low-level radioactive wastes. Reference "grab" samples were also obtained from other nearby streams and bodies of water outside the Laboratory's drainage area. The sampling locations as shown in Fig. 4 were as follows:

Off-Site (Peconic River, proceeding downstream)

A - Peconic River at Schultz Rd., 15,900 ft. downstream

B - Peconic River at Wading River-Manorville Rd., 23,100 ft. downstream

C - Peconic River at Manorville, 35,000 ft. downstream

D - Peconic River at Calverton, 46,700 ft. downstream

R - Peconic River at Riverhead, 63,500 ft. downstream

Controls (Not in BNL Drainage)

E - Peconic River, upstream from BNL effluent outfall

F - Peconic River, north tributary (independent of BNL drainage)

H - Carman's River - outfall of Yaphank Lake

I - Artist Lake (maintained by water table, no surface outfall)

J - Lake Panamoka (maintained by water table, no surface outfall)

The individual monthly and yearly average gross beta and tritium concentrations at the downstream and control locations are shown in Table IX. A comparison suggests that the concentrations of BNL effluents in the stream diminish rapidly downstream of the outfall to near background levels at the downstream sampling locations.

During the summer of 1972, additional sampling of the stream bottom sediment, of immersed and emergent vegetation, and of small stream fauna was conducted along the length of the Peconic. Control samples were obtained from the Carman's River. Sampling locations corresponded to those used for monthly water samples. In addition, samples were obtained on-site at the following locations:

On-Site (proceeding downstream)

K - Peconic River at effluent outfall

L - Peconic River, 1300 ft. below effluent outfall

L′ - Peconic River, 2000 ft. below effluent outfall

M - Peconic River, 2600 ft. below effluent outfall (at former BNL boundary)

M-Q - Peconic River, ~ 4,500 ft. below effluent outfall

Q - Peconic River, 6900 ft. downstream (at BNL boundary)

Off-Site

V - Peconic River (54,600 ft. downstream)

W - Peconic River (59,600 ft. downstream)

The sediment data are shown in Table X. Small concentrations of ^{60}Co and ^{65}Zn, as well as small increments above the ^{137}Cs, U and Th backgrounds are apparent in some samples obtained on-site and in the upper reaches of the Peconic. The corresponding vegetation data are shown in Table XI. These show considerable scatter. Small concentrations of ^{60}Co and also of ^{137}Cs over prevailing backgrounds were found in vegetation in the upper reaches of the Peconic, at the BNL boundary and immediately downstream. A few samples of fish and turtles were also obtained along the upper reaches of the Peconic. These data, which are shown in Table XII, appear comparable to those found in vegetation. The concentrations found in these samples were less than 0.3% of radiation concentration guides(1) calculated on the basis of an assumed intake of 50 grams/day.

Potable Water Supply Wells

The Laboratory's potable water supply wells and cooling water supply wells are about 100 feet deep, or about 50 feet below the water table in the Long Island surface layer of glacial outwash, sand and gravel. As apparent from Fig. 5, most of these wells are located generally west to northwest, and therefore upstream in the local ground water flow pattern(4), of the Laboratory's principal facilities. The exceptions are main well Nos. 1 and 3, and the small well No. 5 adjacent to the sand filter beds. A total of about 5×10^6 gal/day is pumped from them.

Monthly grab samples were scheduled for these wells. They were analyzed for gross alpha, gross beta and tritium. All gross alpha concentrations were $< 10^{-9}$ μCi/ml, and all tritium concentrations were $< 10^{-6}$ μCi/ml. The

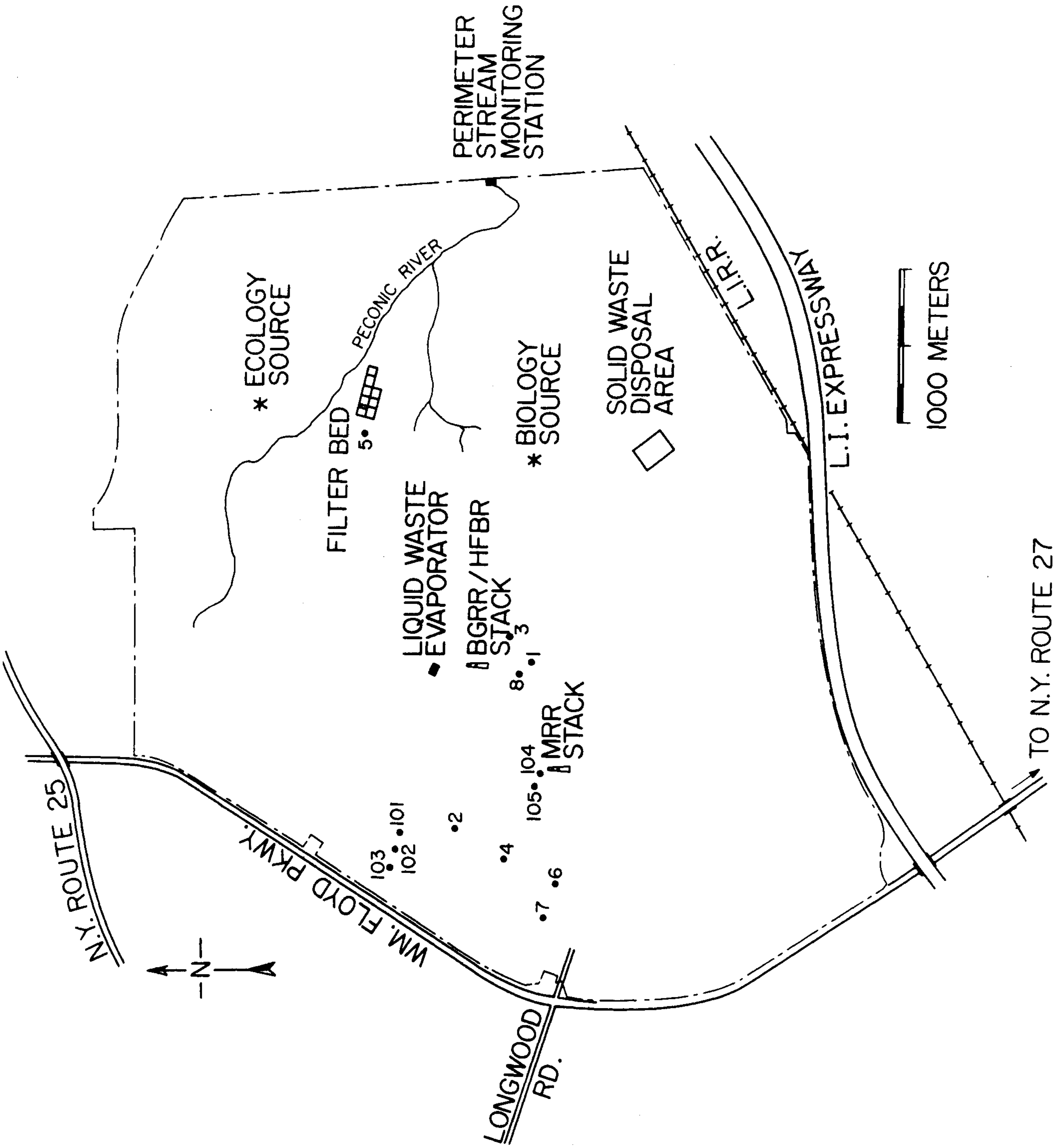

PERIMETER STREAM MONITORING STATION
ECOLOGY SOURCE
PECONIC RIVER
FILTER BED
5
LIQUID WASTE EVAPORATOR
BGRR / HFBR STACK
BIOLOGY SOURCE
SOLID WASTE DISPOSAL AREA
L.I.R.R.
L.I. EXPRESSWAY
1000 METERS
1
2
3
4
6
7
8
MRR STACK
101
102
103
104
105
N.Y. ROUTE 25
WM. FLOYD PKWY.
N
LONGWOOD RD.
TO N.Y. ROUTE 27

FIGURE 5

gross beta results are set forth in Table XIII. There were no differences in the gross beta concentrations in these wells which might be attributed to BNL effluents.

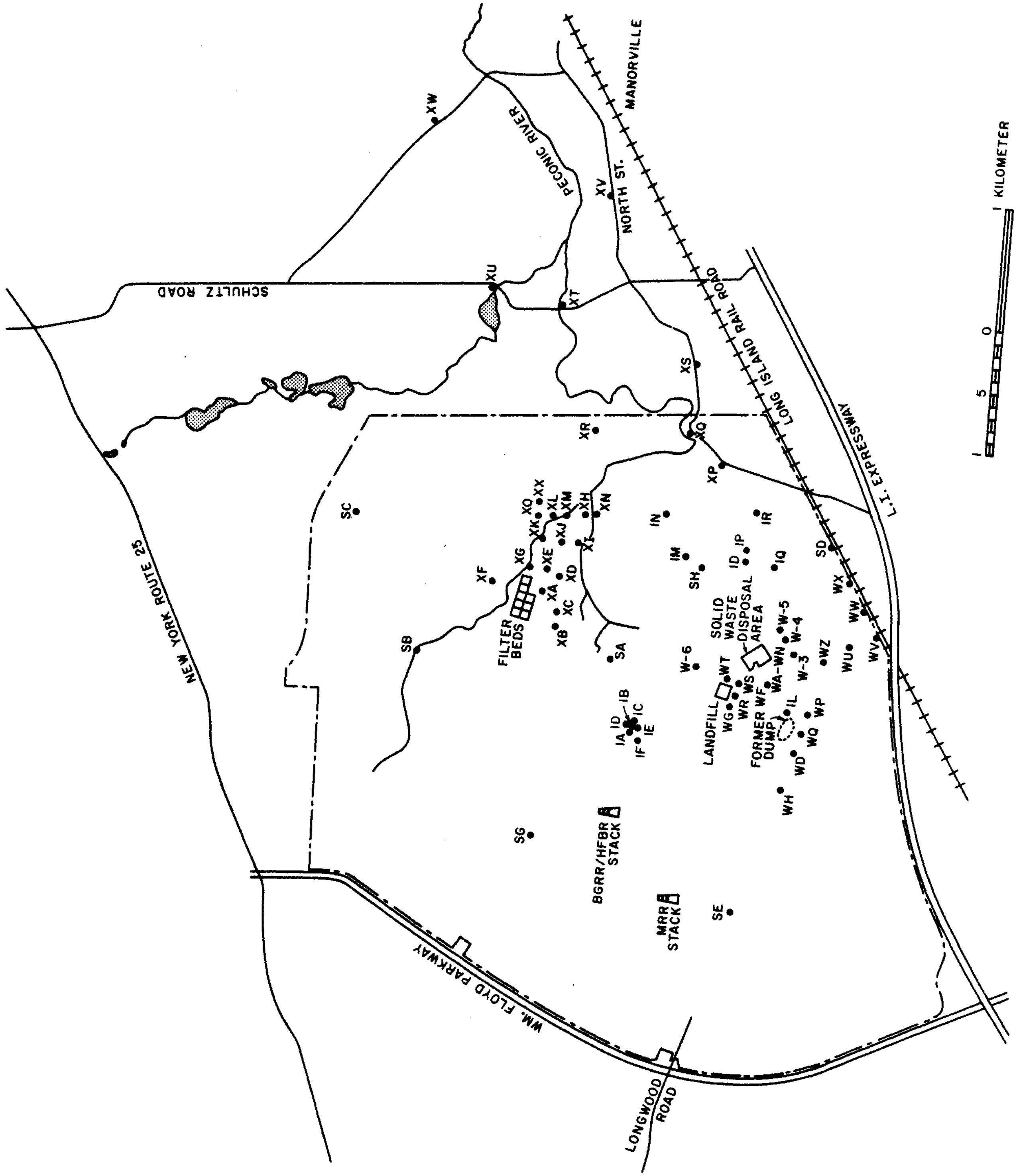
Recharge Basins

About 4 x 10^6 gal/day of the total water pumped from the ground water supply under the BNL site, is returned to this supply in three large open recharge sumps located about 1 km north of the Liquid Waste Evaporator Facility, about 1 km east of the HFBR, and about 1 km south of the MRR. These are monitored by routine monthly grab sampling. Their average gross beta and tritium concentrations, shown in Table XIV, were only very slightly increased above those in the BNL supply wells, and were about 0.1% of the applicable radiation concentration guide for unidentified gross beta emitters, and o.03% of that for tritium in drinking water.

Ground Water Surveillance

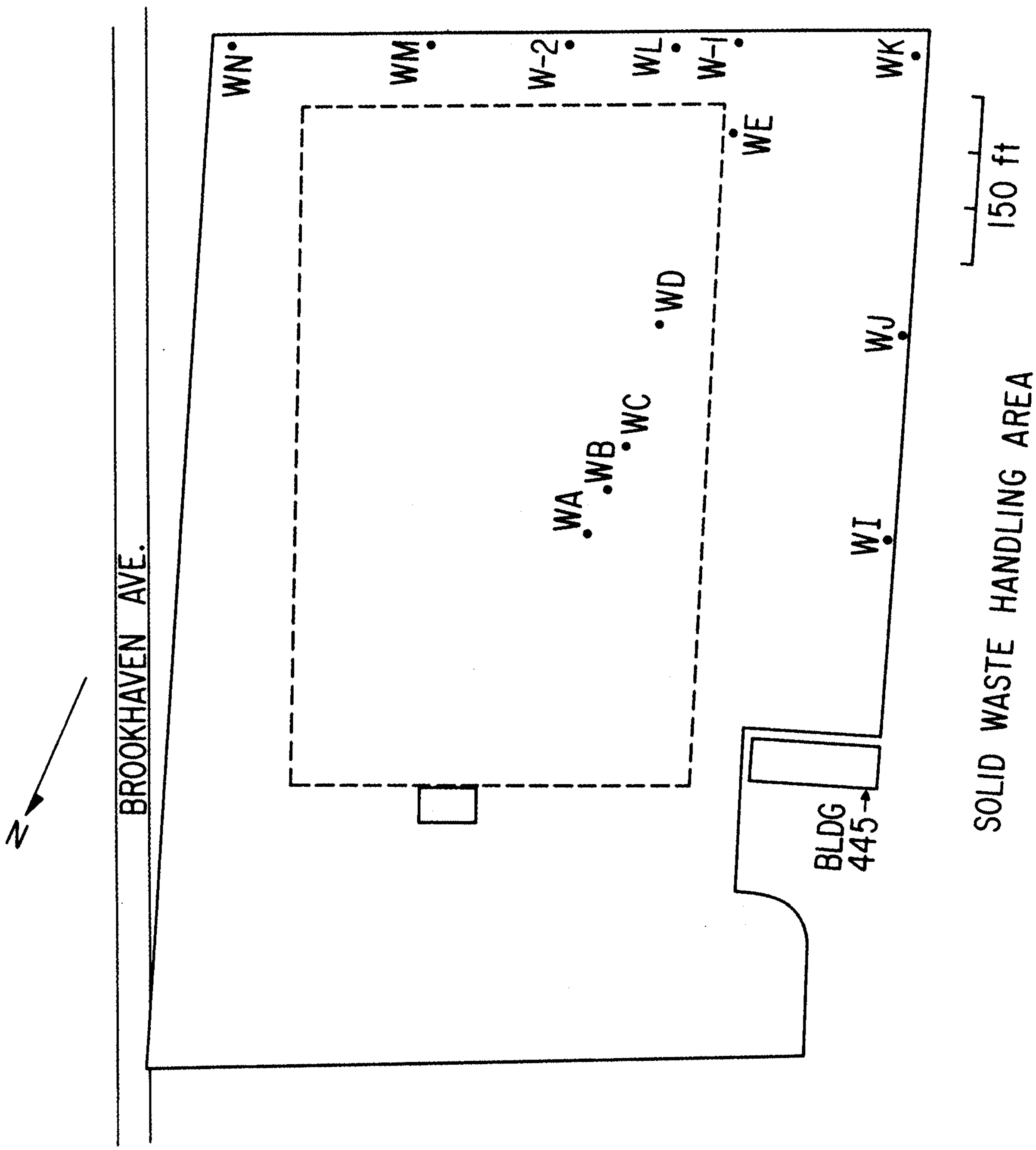
Several areas from which there is a potential for the migration of radioactivity downward from the surface into the saturated zone of ground water, have previously been identified. Ground water sampling was routinely conducted in shallow wells located adjacent to and downstream from these areas. These areas include the Sand Filter Beds and downstream along the Peconic River, the Solid Waste Disposal Area, the former open-pit dump and the sanitary landfill which replaced it in 1967, and the Decontamination Facility Sump. Their locations and those of the related ground water surveillance wells are shown in Fig.6-A. Detailed locations of the several wells installed at the Solid Waste Disposal Area are shown in Fig. 6-B.

For convenience in assessing the data, the wells have been divided into several groups. Yearly average gross alpha, gross beta and tritium concentrations of the wells generally in the proximity of the Sand Filter Beds and downstream on the Peconic River are summarized in Table XV. At least one



NEW YORK ROUTE 25
SCHULTZ ROAD
PECONIC RIVER
NORTH ST.
MANORVILLE
LONG ISLAND RAIL ROAD
L.I. EXPRESSWAY
WM. FLOYD PARKWAY
LONGWOOD ROAD
FILTER BEDS
SOLID WASTE DISPOSAL AREA
LANDFILL
FORMER DUMP
BGRR/HFBR STACK
MRR STACK
XW
XV
XU
XT
XS
XR
XQ
XP
XF
XG
XK
XO
XX
XL
XM
XJ
XH
XN
XI
XE
XD
XA
XC
XB
SA
SB
SC
SD
SE
SG
SH
IN
IM
ID
IP
IR
IQ
IA
IB
IC
IE
IF
IL
W-6
W-5
W-4
W-3
WT
WS
WR
WG
WF
WA-WN
WZ
WU
WV
WW
WX
WP
WQ
WD
WH
0
5
1 KILOMETER

FIGURE 6A



BROOKHAVEN AVE.
N
WN
WM
W-2
WL
W-1
WK
WE
150 ft
WD
WJ
WC
WB
WA
WI
SOLID WASTE HANDLING AREA
BLDG
445

FIGURE 6B

sample from most of these locations was also analyzed for ^{90}Sr and ^{137}Cs (by gamma analysis) during the year. As available, these data are also indicated. Corresponding information for the wells generally in the proximity or downstream of the Solid Waste Packaging Area, the landfill and dump zones, and of the Decontamination Facility Sump (about 1 km east of the HFBR) is summarized in Table XVI-A.

From these data it appears that the spread of contamination in the ground water, if any, is limited to within one hundred meters of the identified foci. Adjacent to the sand filter beds and to the Peconic River, tritium concentrations were less than or comparable to those found in the liquid effluent stream during 1972. Somewhat higher gross beta and strontium-90 concentrations were found in on-site surveillance wells adjacent to the former perimeter stream sampling location. Gross beta, ^{90}Sr and tritium concentrations above background were found in some wells adjacent to the Solid Waste Packaging Area, to the landfill and dump zones, and to the Decontamination Facility Sump. However, their concentrations in wells on or near the site boundary were at or near background levels.

The purity of water samples obtained from a limited number of these wells, as shown in Table XVI-B, was within quality standards established for ground water by the New York State Department of Environmental Conservation[(3)].

Milk Sampling

Quarterly samples of milk were obtained from the two nearest dairy farms located 10 km south-southwest and 10 km south-southeast of Brookhaven. These samples were analyzed for gamma-emitters and then processed through an ion exchange column to improve the lower detection capability for ^{131}I. The data are indicated in Table XVII. There was no significant difference between those for the first two quarters and the typical 1972 concentrations reported[(5)] for milk samples in the northeast region of the United States by the Environmental

Protection Agency. For the last two quarters, the average quarterly concentration of ^{90}Sr in the milk from a farm 10 km southeast of the Laboratory was reported by the New York State Department of Environmental Conservation[6] as being among the highest of any of their thirty state-wide sampling locations. A comparison with previous years suggests that this is in part a seasonal effect. The feeding practices of this farm are under investigation by the Department to ascertain to what extent they may be unique. There was no plausible relationship between these concentrations and Laboratory effluents.

Grass and Soil Sampling

Two sets of samples, one early in the growing season and one toward its end, were collected adjacent to most of the BNL perimeter monitoring stations and from a number of off-site farms. A few on-site samples were also obtained. These were analyzed for gamma-emitting nuclides. The data for soil are shown in Table XVIII and those for grass in Table XIX. Comparison of off-site samples from sites in a prevailing downwind direction (6 km northeast and 10 km southeast) with other samples discloses no consistent differences. Comparison of off-site samples with on-site samples suggests the possible presence of a slight increase of ^{137}Cs in samples obtained adjacent to the Solid Waste Disposal Area over those in the off-site samples.

DOSE ESTIMATES

The largest potential radiation exposures related to Brookhaven National Laboratory activities and effluents are to hypothetical individuals located at the site boundary. These have been indicated in the previous sections. These have been small fractions of the applicable radiation protection standards or concentration guides. Most of the areas immediately adjacent to the Laboratory are unpopulated. Due to the rapid dimunition of external radiation with distance and to the dilution of radioactivity in liquid effluents, the estimated exposures to typical individuals have been much smaller, and in all cases less than 1% of the applicable standards.

In addition to a background of 87.6 millirems, the calculated yearly exposure at the north boundary attributed to the Ecology Forest source was 15.6 millirems, or 3.1% of the applicable AEC Radiation Protection Standard[1]. The typical dose to about fifty persons living adjacent to the Laboratory in this direction is calculated to be 2.5 millirems, and their total calculated dose was 0.13 man-rems, compared to a total background dose of 4.38 man-rems. Measurements made by the Accelerator Survey Group of the Health Physics and Safety Division indicate a yearly boundary exposure of < 5.0 millirems, mostly from the neutron component of scattered radiation. Their experimental measurements indicate that this scattered radiation also falls off very rapidly with distance. Making the considervative assumption that the population density adjacent to the Laboratory was 300 persons/mi^2, the total calculated dose was about 0.10 man-rems, compared to a total background dose of 990.2 man-rems.

At the site boundary, the yearly average measured concentration of tritium vapor in air, 3.5×10^{-12} μCi/ml, would correspond to a yearly dose of less than 0.01

millirems. If this average measured boundary concentration is assumed to diminish with distance by diffusion at the same rate as that previously reported[7] for the ^{41}Ar contained in the air effluent from the Brookhaven Graphite Research Reactor, and a uniform population density of 300 persons/mi^2 is also assumed, the calculated total yearly dose to some 52,500 persons (within a radius of 7.5 miles) is 0.05 man-rems. During this same time the total background to this same number of persons would have been 4599.0 man-rems.

The largest potential dose attributable to Brookhaven's liquid effluents would have been 15.0 millirems to the thyroid and 14.4 millirems (over 70 years) to the bone to a hypothetical child drinking water from the Peconic River at the site boundary. In practice the river is not used for drinking water, nor for irrigation, nor any other similar purpose in which direct ingestion can be adduced. The upper portions of the river, in which a small excess of background concentrations in sediments, vegetation and fish was found, is not utilized for other than occasional sports fishing by a few individuals. Making the conservative assumptions that the average ^{137}Cs concentration associated with Brookhaven effluents was $2 \times 10^{-9} \mu Ci/gm$, and that the total catch of fish by 100 fishermen from this narrow confine at the river was 1×10^3 kg, their total ingestion was 2×10^{-6} Ci, corresponding to an individual dose of 0.63 millirems and a total exposure of 6.25×10^{-2} man-rems. During this time, the total background of these same 100 fishermen would have been 8.76 man-rems.

Thus, during 1972 the Laboratory activities and effluents can be seen to have constituted an inconsequential addition to the normal background exposure of persons living or temporarily in its vicinity.

REFERENCES

1. ----------, Standards for Radiation Protection, USAEC Manual, Chapter 0524, Appendix A, Table II, Guide for Uncontrolled Areas (1968).

2. ----------, Sources of Water Supply, Part 170, Subchapter 6, Chapter III, Title 10 (Health), Official Compilation of Codes, Rules and Regulations of the State of New York.

3. ----------, Classification and Standards Governing the Quality and Purity of Waters of New York State, Schedule I, Part 703.4, Title 6, Official Compilation of Codes, Rules and Regulations of New York State, Department of Environmental Conservation.

4. M. A. Warren, W. deLaguna and N. J. Lusczynski, Hydrology of Brookhaven National Laboratory and Vicinity, Geo. Survey Bull. 1156-C (1968).

5. ----------, Radiation Data and Reports, 14:5 - 15:4, U.S. Env. Protn. Agency, (May 1972 - April 1973).

6. W. G. Bentley, Radioactivity in Air, Milk and Water, Environmental Radiation Bulletins 72-1, 72-2, 72-3 and 72-4, State of New York Dept. of Env. Conservation.

7. A. P. Hull, Some Comparisons of the Environmental Risks from Nuclear- and Fossil-Fueled Power Plants, Nuclear Safety, Vol. 12, No. 3, (May-June 1971).

8. ----------, Background Material for the Development of Radiation Protection Standards, FRC Report No. 2 (1961).

TABLE I

1972 BNL ENVIRONMENTAL MONITORING
BACKGROUND AND SOURCE RADIATION LEVELS
(mrem/wk)*

Month	P-2	P-4	P-7	Northeast Perimeter (Bkg.)	Northeast Perimeter (Source)	Northeast Perimeter (Total)	All Stations (Background)
Jan.	1.65	1.78	1.96	1.58	0.24	1.82	1.74
Feb.	1.60	1.76	1.90	1.57	0.23	1.80	1.71
March	1.58	1.72	1.80	1.52	0.24	1.76	1.66
April	1.63	1.70	1.89	1.54	0.27	1.81	1.68
May	1.54	1.62	1.78	1.51	0.30	1.81	1.61
June	1.57	1.63	1.69	1.57	0.33	1.90	1.62
July	1.56	1.73	1.68	1.60	0.37	1.97	1.64
Aug.	1.64	1.83	1.84	1.68	0.36	2.04	1.75
Sept.	1.67	1.85	1.89	1.72	0.34	2.06	1.78
Oct.	1.66	1.80	1.86	1.69	0.31	2.00	1.75
Nov.	1.66	1.81	1.92	1.74	0.28	2.02	1.78
Dec.	1.59	1.59	1.72	1.58	0.23	1.81	1.62
Average	1.61	1.72	1.82	1.60	0.30	1.90	1.69
Total (mR/yr)	83.50	89.30	94.50	83.00	15.60	98.60	87.60
Radiation Protection Standard for Uncontrolled Areas (1)					500		

Estimated error of individual monthly measurement at 95% confidence level: ± 0.10 mrem/wk.

* Data indicated are measured milliroentgen values, which are assumed to be equivalent to millirems, within the limits of measurement error.

TABLE II

1972 BNL ENVIRONMENTAL MONITORING MONTHLY AVERAGE GROSS ALPHA AND GROSS BETA CONCENTRATIONS, AIR PARTICULATE FILTERS (pCi/m^3 or 10^{-12} µCi/ml)

Month	Location	Gross Alpha No.	Gross Alpha Average	Gross Alpha Maximum	Gross Alpha Minimum	Gross Beta No.	Gross Beta Average	Gross Beta Maximum	Gross Beta Minimum
Jan.	Waste Disposal	22	0.0012	0.0039	< 0.0001	22	0.1115	0.4650	0.0174
	S.W. Perimeter	-	-	-	-	5	0.1122	0.1840	0.0338
	N.E. Perimeter	-	-	-	-	5	0.0998	0.1760	0.0532
Feb.	Waste Disposal	21	0.0010	0.0024	< 0.0001	21	0.0783	0.1680	0.0523
	S.W. Perimeter	-	-	-	-	5	0.0716	0.1270	0.0523
	N.E. Perimeter	-	-	-	-	3	0.0828	0.1140	0.0451
March	Waste Disposal	23	0.0010	0.0019	< 0.0001	23	0.0869	0.2460	0.0170
	S.W. Perimeter	-	-	-	-	4	0.0898	0.1170	0.0554
	N.E. Perimeter	-	-	-	-	4	0.0808	0.1080	0.0763
April	Waste Disposal	21	0.0010	0.0021	0.0003	21	0.0965	0.2940	0.0222
	S.W. Perimeter	-	-	-	-	5	0.1142	0.2030	0.0465
	N.E. Perimeter	-	-	-	-	5	0.1011	0.1450	0.0465
May	Waste Disposal	21	0.0009	0.0025	0.0005	21	0.1430	0.2830	0.0609
	S.W. Perimeter	-	-	-	-	4	0.1246	0.1850	0.0736
	N.E. Perimeter	-	-	-	-	4	0.1202	0.1570	0.0558
June	Waste Disposal	22	0.0006	0.0018	< 0.0001	22	0.1734	0.3690	0.0837
	S.W. Perimeter	-	-	-	-	5	0.2040	0.2570	0.1130
	N.E. Perimeter	-	-	-	-	5	0.1720	0.2580	0.0612
July	Waste Disposal	20	0.0013	0.0026	0.0006	20	0.2005	0.3700	0.0680
	S.W. Perimeter	-	-	-	-	5	0.1754	0.3030	0.0881
	N.E. Perimeter	-	-	-	-	5	0.1696	0.3120	0.0848
Aug.	Waste Disposal	22	0.0016	0.0036	0.0009	22	0.1233	0.1630	0.0697
	S.W. Perimeter	-	-	-	-	4	0.1232	0.1670	0.0839
	N.E. Perimeter	-	-	-	-	4	0.1056	0.1300	0.0925
Sept.	Waste Disposal	21	0.0012	0.0034	0.0003	21	0.0927	0.1350	0.0305
	S.W. Perimeter	-	-	-	-	4	0.0997	0.1270	0.0579
	N.E. Perimeter	-	-	-	-	4	0.0838	0.1100	0.0387
Oct.	Waste Disposal	22	0.0009	0.0020	0.0002	22	0.0643	0.1620	0.0304
	S.W. Perimeter	-	-	-	-	5	0.0525	0.0897	0.0312
	N.E. Perimeter	-	-	-	-	5	0.0409	0.0475	0.0359
Nov.	Waste Disposal	19	0.0007	0.0014	0.0003	19	0.0529	0.1060	0.0191
	S.W. Perimeter	-	-	-	-	4	0.0431	0.0513	0.0279
	N.E. Perimeter	-	-	-	-	4	0.0358	0.0430	0.0214
Dec.	Waste Disposal	20	0.0009	0.0027	0.0002	20	0.0428	0.0848	0.0135
	S.W. Perimeter	-	-	-	-	5	0.0482	0.0708	0.0291
	N.E. Perimeter	-	-	-	-	5	0.0375	0.0508	0.0286
Average	Waste Disposal	254	0.0010	0.0039	< 0.0001	254	0.1006	0.4650	0.0135
	S.W. Perimeter	-	-	-	-	55	0.0879	0.3030	0.0279
	N.E. Perimeter	-	-	-	-	54	0.0938	0.3120	0.0214
Est. % Error of Individual Sample				± 25			± 10		
Radiation Concentration Guide(1) for Unidentified Mixtures			0.100				100		

TABLE III

1972 BNL ENVIRONMENTAL MONITORING

AVERAGE TRITIUM CONCENTRATIONS IN AIR (pCi/m^3 or 10^{-12} μCi/ml)

Month	No. of Samples	Gross	Background**	Net**
			S.W. Perimeter*	
January	1	4	2	2
February	1	5	3	2
March	1	5	2	3
April	1	3	2	< 1
May	1	4	2	2
June	1	8	3	5
Average		5	2	3
			N.E. Perimeter*	
July	1	6	2	4
August	1	8	3	5
September	2	4	1	3
October	1	12	1	11
November } December }	1	3	1	2
Average		6	2	4
Radiation Concentration Guide(1)		2×10^5	2×10^5	2×10^5

* Sample located in direction which is most frequently downwind for dispersion-diffusion conditions expected to produce largest perimeter concentrations of stack effluent HTO for the season.

**Tritium analysis made of monthly composite samples of water vapor. The net tritium concentration in this, arrived at by subtracting that in an off-site precipitation sample, is converted to air concentration on the assumption that on the average 1 pCi/ml in vapor corresponds to 10 pCi/m^3 in air, which is strictly so at 59°F and 50° R.H.

Estimated Error (at 95% confidence limits): ± 1 pCi/m^3, or ± 50%.

TABLE IV

1972 BNL ENVIRONMENTAL MONITORING
MONTHLY AVERAGE OF γ-EMITTING NUCLIDES IN MONTHLY COMPOSITE
AIR PARTICULATE AND CHARCOAL FILTERS (pCi/m^3 or 10^{-12} $\mu Ci/ml$)

Month	^{7}Be	^{65}Zn	$^{95}Zr-Nb$	^{106}Ru	^{125}Sb	^{131}I**	^{137}Cs	$^{140}Ba-La$	^{144}Ce	Gβ
January	0.086	0.001	0.007	0.006	0.001	0.005	0.003	0.012	0.013	0.109
February	0.153	0.001	0.008	0.008	0.002	0.001	0.003	< 0.001	0.016	0.083
March	0.156	0.002	0.007	0.010	0.002	0.004	0.005	0.002	0.015	0.084
April	0.180	< 0.001	0.023	0.006	0.003	0.001	0.005	0.006	0.014	0.103
May	0.230	0.001	0.044	Pending	0.002	< 0.001	0.006	0.006	0.015	0.128
June	0.262	0.002	0.049	Pending	0.004	< 0.001	0.009	< 0.001	0.021	0.186
July	0.228	0.002	0.035	Pending	0.004	< 0.001	0.008	< 0.001	0.031	0.182
August	0.196	0.002	0.021	Pending	0.002	< 0.001	0.005	< 0.001	0.015	0.119
September	0.152	0.001	0.009	Pending	0.002	< 0.001	0.003	< 0.001	0.011	0.094
October	0.119	0.001	0.004	Pending	Pending	< 0.001	0.003	< 0.001	0.012	0.052
November	0.086	0.001	0.002	Pending	Pending	< 0.001	0.001	< 0.001	0.008	0.045
December	0.070	0.001	0.001	Pending	Pending	< 0.001	0.001	< 0.001	0.005	0.043
Average	0.160	0.001	0.018	Pending	0.002*	0.001	0.005	0.003	0.015	0.094
Est. % Error of Individual Sample	± 25	± 50	± 25	± 33	± 33	± 50	± 33	± 50	± 33	± 10
Radiation Concentration Guide(1)	$4x10^4$	$2x10^3$	$1x10^3$	200	900	100	500	1,000	200	100

* Based on partial year's data

**Charcoal filter collections; all other nuclides collected on air particulate filters.

TABLE V

1972 BNL ENVIRONMENTAL MONITORING
MONTHLY AVERAGE GROSS BETA CONCENTRATION, TOTAL GROSS BETA ACTIVITY,
AND PRINCIPAL NUCLIDE ACTIVITY IN PRECIPITATION

				Nuclide Activity (nCi/m^2 or 10^{-3} µCi/m^2)							
Month	Amount Inches	Gβ Conc. (pCi/l or 10^{-9} µCi/ml)	Gβ Activity (nCi/m^2 or 10^{-3} µCi/m^2)	^{7}Be	^{65}Zn	^{90}Sr	^{95}Zr-Nb	^{131}I	^{137}Cs	^{140}Ba-La	^{144}Ce
Jan.	2.05	44	2.4	3.0	< 0.1	0.05	0.2	0.1	0.1	0.3	0.7
Feb.	2.85	20	1.9	3.4	< 0.1	0.07	0.2	< 0.1	< 0.1	< 0.1	1.7
Mar.	4.12	24	2.6	7.0	< 0.1	0.11	0.3	0.5	0.2	N/A	0.8
Apr.	3.81	522	15.9	18.3	< 0.1	0.11	3.4	0.4	0.2	1.5	3.7
May	4.68	57	6.8	12.5	< 0.1	0.08	1.8	0.1	0.2	0.3	1.7
June	4.88	54	7.4	19.0	< 0.1	0.10	2.5	0.2	0.4	0.1	0.4
July	1.81	22	1.4	3.1	0.1	0.02	0.2	< 0.1	< 0.1	< 0.1	0.4
Aug.	1.06	8	0.2	* 2.9	< 0.1	0.01	0.2	< 0.1	0.1	< 0.1	0.4
Sept.	3.62	13	2.0								
Oct.	7.76	4	0.9			0.03					
Nov.	3.07	10	0.8	** 9.2	< 0.1		0.1	< 0.1	0.1	< 0.1	0.4
Dec.	5.37	7	1.0			< 0.07					
Total	45.08	68†	43.3	78.4	< 1.0	0.65	8.9	1.5	1.4	2.4	10.2
Est.Error	0.50	± 7	± 2.2	± 15.7		± 0.10	± 0.9	± 0.5	± 0.4	± 0.7	± 2.6
Radiation Concentration Guide(1)††		3×10^3									

* Two month sample
**Three month sample
† Average
††For release to uncontrolled areas of mixture of radionuclides containing < 10% ^{90}Sr, $^{125-133}$I and long-lived natural alpha-emitting nuclides.

TABLE VI

1972 BNL ENVIRONMENTAL MONITORING

MONTHLY AVERAGE TRITIUM CONCENTRATION AND ACTIVITY IN PRECIPITATION

Month	BNL Conc. (nCi/l or 10^{-6} μCi/ml)	BNL Activity (nCi/m^2 or 10^{-3} μCi/m^2)	OFF-SITE Conc. (nCi/l or 10^{-6} μCi/ml)
January	0.322	16.9	0.148
February	0.256	25.0	0.134
March	0.226	24.5	0.253
April	0.475	45.4	0.234
May	0.453	63.5	0.221
June	0.546	67.1	0.221
July	0.247	14.7	0.230
August	< 0.150	< 3.2	0.291
September	< 0.150	< 12.6	< 0.150
October	0.152	33.8	< .050
November	0.188	28.0	0.103
December	0.193	23.4	N/A
Total		350.2	
Average	0.277		0.161
Estimated Error	± 0.075	± 0.075	± 0.075
Radiation Concentration Guide (1)	3×10^3		3×10^3

*For tritium in water released to the off-site environment.

TABLE VII

1972 BNL ENVIRONMENTAL MONITORING
TOTAL ACTIVITIES AND AVERAGE CONCENTRATIONS OF IDENTIFIABLE NUCLIDES

CLARIFIER

(mCi)

Month	Flow x $10^{11}cm^3$	^{3}H	^{7}Be	^{60}Co	^{65}Zn	^{90}Sr	^{95}Zr-Nb	^{131}I	^{137}Cs	^{144}Ce	Gβ*
Jan.	1.194	227	0.26	0.04	0.03	0.25	< 0.10	2.78	0.28	0.49	4.30
Feb.	0.988	143	2.49	0.03	< 0.01	0.18	< 0.10	0.73	0.21	0.28	4.28
March	0.984	133	1.10	0.02	0.02	0.16	< 0.10	0.35	0.19	0.13	2.87
April	1.265	290	0.52	0.03	0.06	0.12	0.02	1.88	0.17	1.19	4.47
May	1.298	134	0.62	0.05	< 0.01	0.11	0.03	1.09	0.22	0.22	3.23
June	1.268	96	1.08	0.10	< 0.01	0.14	0.03	0.55	0.25	0.25	3.28
July	1.884	273	0.98	0.01	< 0.01	0.25	0.05	3.32	0.81	0.81	8.55
Aug.	1.564	350	1.48	0.04	0.04	0.08	< 0.01	2.57	0.31	0.31	4.47
Sept.	1.438	262	0.22	0.04	0.02	0.06	< 0.10	1.42	0.25	0.73	2.98
Oct.	1.740	2,122	0.74	0.05	< 0.01	0.18	< 0.10	0.99	0.34	0.73	4.10
Nov.	0.897	885	1.81	0.04	< 0.01	0.10	0.02	1.04	0.31	0.24	3.96
Dec.	1.043	1,343	2.32	0.32	< 0.01	3.40	0.02	1.00	2.09	0.21	14.65
Total	15.563	6,258	13.62	0.77	0.21	5.03	0.20	18.31	5.43	5.49	61.14
Avg. Conc. (pCi/l or 10^{-9} μCi/ml)		4,000	8.7	0.5	0.1	3.2	0.1	11.7	3.4	3.5	39.2
% of Total*			22	1	< 1	8	< 1	30	9	9	100

CHLORINE HOUSE

Month	Flow x $10^{11}cm^3$	^{3}H	^{7}Be	^{60}Co	^{65}Zn	^{90}Sr	^{95}Zr-Nb	^{131}I	^{137}Cs	^{144}Ce	Gβ*
Jan.	0.968	211	0.31	0.01	0.02	0.64	< 0.01	0.96	1.00	0.50	3.60
Feb.	0.816	110	0.19	0.02	< 0.01	0.45	0.01	0.48	0.85	0.36	2.28
March	0.873	90	< 0.10	< 0.01	0.11	0.43	< 0.01	0.31	0.97	0.25	2.41
April	1.087	222	0.19	0.05	0.02	0.31	0.19	0.47	0.92	0.59	2.51
May	1.155	108	0.34	0.01	0.01	0.27	0.04	0.38	0.83	0.83	2.60
June	0.957	87	0.12	0.02	0.01	0.28	0.02	0.16	0.91	0.91	2.17
July	1.575	222	0.13	0.03	< 0.01	0.32	0.03	0.70	0.88	0.88	2.86
Aug.	1.262	230	0.32	0.01	0.01	0.21	0.01	0.23	0.82	0.82	2.34
Sept.	1.197	239	0.08	0.02	< 0.01	0.15	< 0.01	0.12	0.69	0.18	1.45
Oct.	1.314	1,678	0.09	0.02	< 0.01	0.13	< 0.01	0.45	0.58	0.08	1.71
Nov.	0.798	740	< 0.10	< 0.01	0.03	0.16	< 0.01	0.50	0.34	< 0.10	1.56
Dec.	0.974	1,240	0.24	0.02	< 0.01	0.88	< 0.01	0.16	0.39	0.20	4.15
Total	12.976	5,176	2.11	0.22	0.34	4.23	0.43	4.92	9.18	5.65	29.64
Avg. Conc.(pCi/l or 10^{-9} μCi/ml)		4,000	1.6	0.2	0.3	3.3	0.3	3.8	7.1	4.4	22.9
% of Total*			8	1	1	16	2	18	34	19	100

*Includes γ only emitters; does not include ^{3}H.

TABLE VII (Cont'd)

GROUND WATER (mCi)

	Flow x 10^{11} cm^3	^3H	^7Be	^{60}Co	^{65}Zn	^{90}Sr	^{95}Zr-Nb	^{131}I	^{137}Cs	^{144}Ce	Gβ*
Total	2.59	1,140	0.42	0.05	0.08	0.86	0.08	0.99	1.84	1.14	5.94
Avg. Conc. (pCi/l)		4,000	1.6	0.2	0.3	3.3	0.3	3.8	7.1	4.4	22.9
% of Total		-	8	1	1	16	2	18	34	19	100
Radiation Concentration Guide(1) (nCi/l or 10^{-6} μCi/ml)		$3x10^3$	$2x10^6$	$5x10^4$	$1x10^5$	300	$6x10^4$	300	$2x10^4$	$1x10^4$	1,230**

*Includes γ only emitters; does not include ^3H

**See text p. 14

TABLE VIII-A

1972 BNL ENVIRONMENTAL MONITORING

TOTAL ACTIVITIES AND AVERAGE CONCENTRATIONS OF IDENTIFIABLE NUCLIDES

FORMER PERIMETER
(mCi)

Month	Flow x 10^{11} cm^3	^{3}H	^{7}Be	^{60}Co	^{65}Zn	^{90}Sr	^{95}Zr-Nb	^{131}I	^{137}Cs	^{144}Ce	Gβ*
Jan.	1.052	182	0.33	0.02	< 0.01	0.89	< 0.01	0.87	1.04	0.53	4.09
Feb.	0.919	108	0.14	0.01	< 0.01	0.49	< 0.01	0.44	0.95	0.38	2.11
March	1.049	92	< 0.10	0.02	0.02	0.48	< 0.01	0.18	1.20	0.13	2.20
April	1.256	252	0.12	0.02	0.02	0.38	0.17	0.42	0.80	0.22	2.91
May	1.365	116	0.41	0.01	0.01	0.33	0.10	0.48	0.89	0.89	3.56
June	1.208	84	0.35	0.03	0.02	0.30	0.09	0.15	1.11	1.11	2.68
July	1.576	191	0.14	0.02	< 0.01	0.42	0.02	0.41	0.59	0.59	2.61
Aug.	0.859	163	0.13	0.01	0.01	0.21	< 0.01	0.14	0.34	0.34	1.36
Sept.	0.869	176	0.15	0.03	< 0.01	0.19	< 0.01	0.21	0.65	0.24	1.20
Oct.	1.241	1,482	0.12	0.02	< 0.01	0.14	< 0.01	0.29	0.50	< 0.10	1.78
Nov.	0.798	691	< 0.10	0.01	< 0.01	0.14	< 0.01	0.18	0.32	< 0.10	1.09
Dec.	1.338	1,142	0.15	0.04	< 0.01	0.85	0.02	0.26	0.49	0.58	3.32
Total	13.530	4,679	2.14	0.23	0.12	4.82	0.63	3.93	8.88	5.11	28.91
Avg. Conc.(pCi/l or 10^{-9} μCi/ml)		3,400	1.6	0.2	0.1	3.5	0.5	2.9	6.5	3.8	21.3
% of Total*			7	1	< 1	17	2	14	31	13	100

SITE BOUNDARY

Month	Flow x 10^{11} cm^3	^{3}H	^{7}Be	^{60}Co	^{65}Zn	^{90}Sr	^{95}Zr-Nb	^{131}I	^{137}Cs	^{144}Ce	Gβ*
Jan.	0.072	13	0.02	< 0.01	< 0.01	0.06	< 0.01	0.10	0.07	0.06	0.33
Feb.	0.053	7	0.02	< 0.01	< 0.01	0.03	< 0.01	0.02	0.05	0.02	0.14
March	0.375	33	0.12	0.02	< 0.01	0.17	< 0.01	0.08	0.29	0.06	0.70
April	0.827	138	0.09	< 0.01	0.02	0.29	0.01	0.22	0.48	0.14	2.01
May	1.072	83	0.54	0.01	< 0.01	0.35	0.03	0.33	0.62	0.62	2.64
June	1.126	78	0.42	0.01	0.02	0.36	0.03	0.18	0.54	0.54	2.49
July	1.570	157	0.16	0.02	< 0.01	0.51	0.02	0.12	0.35	0.35	2.51
Aug.	.442	37	0.02	< 0.01	< 0.01	0.15	< 0.01	0.06	0.11	0.11	0.68
Sept.	.159	38	0.02	< 0.01	< 0.01	0.05	< 0.01	0.04	0.05	0.05	0.23
Oct.	.259	331	0.08	< 0.01	0.01	0.07	< 0.01	0.07	0.10	0.04	0.43
Nov.	.588	413	< 0.10	< 0.01	0.01	0.11	< 0.01	0.15	0.18	< 0.10	1.06
Dec.	1.599	1,059	0.57	0.02	< 0.01	0.57	< 0.01	0.20	0.35	0.33	4.26
Total	8.142	2,387	2.11	0.12	0.11	2.72	0.13	1.57	3.19	2.37	17.48
Avg. Conc.(pCi/l or 10^{-9} μCi/ml)		2,950	2.6	0.1	0.1	3.3	0.2	1.9	3.9	2.9	21.4
% of Total*			12	1	1	16	1	9	18	14	100

*Includes γ only emitters; does not include ^{3}H

TABLE VIII-A (Cont'd)

GROUND WATER (mCi)

	Flow x 10^{11} cm^3	^3H	^7Be	^{60}Co	^{65}Zn	^{90}Sr	^{95}Zr-Nb	^{131}I	^{137}Cs	^{144}Ce	Gβ*
Total	6.82	2,320	1.09	0.14	0.07	2.38	0.34	1.98	4.43	2.59	14.50
Avg. Conc.(pCi/l or 10^{-9} μCi/ml)		3,400	1.6	0.2	0.1	3.5	0.5	2.9	6.5	3.8	21.3
% of Total*			7	1	< 1	17	2	14	31	13	100
Radiation Concentration Guide(1)		$3x10^6$	$2x10^6$	$5x10^4$	$1x10^5$	300	$6x10^4$	300	$2x10^4$	$1x10^4$	1,230**

* Includes γ only emitters; does not include ^3H.

**See text p. 14

TABLE VIII-B

1972 BNL ENVIRONMENTAL MONITORING
LIQUID EFFLUENT QUALITY AND PURITY

		BOD (ppm)	Coliform (#/100 ml)	Conductivity (μmho/cm)	Dissolved Oxygen (ppm)	pH	Settleable Solids (mg/1)	Suspended Solids (ppm)	Chlorine (Residual)** (ppm)	Cr (Hex) (ppm)	Nitrate (ppm)	Ammonium Nitrogen (ppm)	Nitrite	Phosphate (ppm)
CLARIFIER EFFLUENT	No.	26	8	44	44	44	240	32	-	46	44	42	40	42
	Avg.	25.2	83,525	206	5.55	6.7	2.1	31	-	0.0	0.62	3.39	0.03	2.96
	Max.	40.8	340,000	300	9.90	7.3	2.6	40	-	0.0	1.50	12.50	0.25	8.00
	Min.	13.5	7,700	150	3.70	5.9	1.2	24	-	0.0	0.22	0.60	0.00	1.70
SAND FILTER BED EFFLUENT	No.	26	39	44	44	44	219	32	234	44	52	48	47	41
	Avg.	2.2	26	191	9.39	6.4	0.0	1	0.76	0.0	1.64	1.1	0.02	2.54
	Max.	4.6	†	250	12.50	6.9	0.0	6	1.00	0.0	3.00	5.0	0.10	4.00
	Min.	0.5	†	160	6.30	5.6	0.0	0	0.73	0.0	0.80	0.0	0.00	0.50
WATER QUALITY STANDARD(2)		-	50	-	> 4.0	6.5 to 8.5	-	5.00	250	0.05	10*	< 2.0	10*	-

* Nitrates and nitrites
** Sample obtained in Peconic River 150° below Chlorine House outfall
† One sample 500/100 - 1; all others zero

TABLE IX

1972 BNL ENVIRONMENTAL MONITORING
MONTHLY DOWNSTREAM AND CONTROL WATER SAMPLES

GROSS BETA (pCi/l or 10^{-9} µCi/ml)

	Downstream Locations					Control Locations				
Month	A	B	C	D	R	E	F	H	I	J
Jan.	5	4	3	2	-	< 1	-	1	1	4
Feb.	5	5	4	3	-	-	8	2	-	7
March	8	6	3	4	3	5	7	2	6	5
April	7	7	3	5	5	8	7	4	6	7
May	11	9	8	9	8	10	9	5	8	9
June	11	6	10	11	10	4	10	5	8	4
July	9	5	5	6	6	7	6	3	6	2
Aug.	7	6	6	5	9	6	3	3	7	3
Sept.	5	3	5	4	9	18	3	2	6	3
Oct.	6	5	4	4	7	8	4	2	5	1
Nov.	7	7	5	6	6	7	5	3	6	2
Dec.	7	5	6	4	-	5	3	3	6	5
Average	7	6	5	5	7*	7	6	3	6	4

^3H (nCi/l or 10^{-6} µCi/ml)

Month	A	B	C	D	R	E	F	H	I	J
Jan.	< 1	< 1	< 1	< 1	-	< 1	-	< 1	< 1	< 1
Feb.	1	< 1	< 1	< 1	-	-	< 1	< 1	-	< 1
March	< 1	< 1	< 1	< 1	< 1	1	< 1	< 1	< 1	< 1
April	1	1	< 1	< 1	< 1	1	< 1	< 1	< 1	1
May	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
June	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
July	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Aug.	1	< 1	< 1	< 1	< 1	1	< 1	< 1	< 1	< 1
Sept.	< 1	< 1	< 1	< 1	< 1	1	< 1	< 1	< 1	< 1
Oct.	2	2	< 1	< 1	< 1	1	< 1	< 1	< 1	< 1
Nov.	< 1	< 1	< 1	< 1	< 1	< 1	2	< 1	< 1	< 1
Dec.	1	2	< 1	1	-	< 1	< 1	< 1	< 1	< 1
Average	1	1	< 1	< 1	< 1*	1	< 1	< 1	< 1	< 1

*Average of 36 weekly composite samples.

Radiation Concentration Guide[(1)]: Gross Beta - 1.23 x 10^{-6} µCi/ml**; ^3H - 3 x 10^{-3} µCi/ml

**See text, p. 14.

TABLE X

1972 BNL ENVIRONMENTAL MONITORING
CONCENTRATIONS OF γ-EMITTING NUCLIDES
IN PECONIC RIVER AND CARMAN'S RIVER SEDIMENTS

Peconic River

Station	^{60}Co	^{65}Zn	^{95}Zr-Nb	^{137}Cs	Th	U	K
	(pCi/kg or $10^{-9}\mu Ci/gm$)						(gm/kg)
M	1,540	393	< 50	2,080	1,588	1,725	1.81
M-Q	880	< 50	< 50	6,870	N/A	N/A	1.03
Q	1,310	186	< 50	2,560	1,770	643	0.59
A	< 100	< 50	< 50	382	232	218	0.38
B	189	64	50	468	359	253	1.83
C	< 100	< 50	82	163	135	300	0.42
D	< 100	148	119	65	606	370	1.54
V	< 100	132	< 50	334	240	347	0.51
W	< 100	< 50	55	< 100	319	367	0.22
R	105	< 50	< 50	146	219	336	< 0.10
Y	< 100	342	< 50	< 100	1,715	1,810	2.92
Reference:							
Carman's River	< 100	< 50	< 50	187	607	478	2.69
Upstream Peconic	< 100	206	< 50	526	895	670	4.16
Estimated Error at 95% Confidence Level:							
	± 10% or ± 100	± 50	± 50	± 10% or ± 100	± 25% or ± 100	± 25% or ± 100	± 10% or ± 0.10

TABLE XI

1972 BNL ENVIRONMENTAL MONITORING
CONCENTRATIONS OF γ-EMITTING NUCLIDES
IN PECONIC RIVER AND CARMAN'S RIVER VEGETATION

Station	^{7}Be	^{60}Co	^{65}Zn	^{95}Zr-Nb	^{137}Cs	Th	U	K
	(pCi/kg or 10^{-9} μCi/gm)							(gm/kg)
M	2,071	77	< 25	405	1,877	454	107	0.32
M-Q	< 100	< 50	< 25	820	2,200	N/A	N/A	3.93
Q	897	817	< 25	188	1,441	516	< 50	2.79
A	1,210	< 50	< 25	162	640	204	189	0.16
B	502	< 50	< 25	< 50	252	101	159	0.23
C	559	233	< 25	< 50	90	170	104	0.41
D	555	62	< 25	< 50	549	108	142	1.03
V	902	< 50	< 25	67	448	60	46	0.53
W	1,190	50	< 25	113	209	163	175	< 0.10
R	502	< 50	< 25	101	101	92	28	0.27
Y	181	< 50	< 25	89	112	84	72	0.16
Reference (Carman's River)								
	668	< 50	< 25	315	272	124	93	5.61
Estimated Error at 95% Confidence Level								
	± 10% or ± 100	± 50	± 25	± 50	± 10% or ± 100	± 10% or ± 50	± 10% or ± 50	± 0.10

TABLE XII

1972 BNL ENVIRONMENTAL MONITORING
CONCENTRATIONS OF γ-EMITTING NUCLIDES
IN ANIMALS OBTAINED FROM THE PECONIC RIVER

Number	Station	^{60}Co (pCi/kg or 10^{-9} μCi/gm)	^{137}Cs (pCi/kg or 10^{-9} μCi/gm)	K (gm/kg)
Snapping Turtles				
1	M	< 50	1,450	1.53
Eastern Painted Turtles				
2	M-Q	< 50	2,745	1.18
4	Q	< 50	1,885	N/A
Catfish				
2	M-Q	< 50	1,770	2.13
2	Q	< 50	1,865	N/A
Estimated Error at 95% Confidence Level		± 50	± 10%	± 0.10
Radiation Concentration Guide(1)		2×10^6	9×10^5	-

*Assumed intake of 50 gms/day

TABLE XIII

1972 BNL ENVIRONMENTAL MONITORING

GROSS BETA AND TRITIUM CONCENTRATIONS IN POTABLE WATER SUPPLY WELLS

GROSS BETA (pCi/l or $10^{-9}\mu Ci/ml$)

Well #	1	2	3	4	5	6	7	101	102	103	104	105	W&R
Jan.	-	< 1.0	1.5	1.3	1.4	2.4	1.3	< 1.0	< 1.0	< 1.0	-	-	-
Feb.	1.9	2.3	1.4	< 1.0	< 1.0	1.6	1.0	1.3	< 1.0	< 1.0	-	-	-
March	1.2	-	< 1.0	1.4	1.8	4.0	2.0	2.4	1.7	2.9	-	-	-
April	<1.0	1.8	1.5	1.7	1.4	2.0	0.9	1.1	< 1.0	1.2	2.1	-	-
May	<1.0	2.3	2.4	1.8	1.5	1.6	2.1	1.7	< 1.0	1.2	3.2	-	-
June	3.2	3.2	2.1	4.2	3.2	3.2	2.3	2.3	2.2	< 1.0	2.3	3.3	1.5
July	3.2	3.6	3.4	< 1.0	3.0	2.1	< 1.0	2.0	< 1.0	1.8	3.1	3.5	< 1.0
Aug.	<1.0	2.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.7	< 1.0
Sept.	2.5	2.3	2.1	1.7	2.3	3.0	1.2	< 1.0	2.5	< 1.0	3.7	2.7	1.8
Oct.	2.3	1.5	2.6	2.0	1.9	1.7	< 1.0	1.6	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Nov.	2.8	3.2	3.2	2.3	2.6	1.8	1.2	1.3	1.3	1.6	-	2.6	1.5
Dec.	1.9	4.2	-	2.4	2.2	4.1	1.9	2.0	0.9	1.7	2.0	-	1.4
Average	1.9	2.4	1.9	1.7	1.9	2.3	1.3	1.4	1.0	1.1	2.3	2.6	1.1

Error of Individual Sample: $\pm 10^{-9}\mu Ci/ml$; Radiation Concentration Guide(1) $10^{-7}\mu Ci/ml$ (for unidentified nuclides in the absence of ^{226}Ra, ^{228}Ra or ^{129}I).

^{3}H (nCi/l or $10^{-6}\mu Ci/ml$)

Well #	1	2	3	4	5	6	7	101	102	103	104	105	W&R
All Months:	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
except:													
April	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
July	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.8	< 0.5
Sept.	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.5	< 0.5	< 0.5	< 0.5	0.5	< 0.5
Oct.	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	< 0.5
Nov.	0.9	< 0.5	< 0.5	< 0.5	< 0.5	0.8	< 0.5	0.7	< 0.5	< 0.5	-	< 0.5	< 0.5
Dec.	< 0.5	< 0.5	< 0.5	< 0.5	0.5	< 0.5	< 0.5	< 0.5	0.7	< 0.5	< 0.5	-	< 0.5
Average	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.5	< 0.5

Error of Individual Sample: $\pm 0.5 \times 10^{-9}\mu Ci/ml$; Radiation Concentration Guide $3 \times 10^{-3}\mu Ci/ml$ (if $^{125-133}I$, ^{90}Sr and alpha emitters not present).

TABLE XIV

1972 BNL ENVIRONMENTAL MONITORING
MONTHLY SUMP SAMPLES
GROSS BETA AND ^3H CONCENTRATIONS

GROSS BETA (pCi/l or 10^{-9} μCi/ml)

Month	N North of AGS No. Samples	N North of AGS Conc.	O East of HIRDL No. Samples	O East of HIRDL Conc.	P Medical No. Samples	P Medical Conc.
Jan.	1	1	1	< 1	-	-
Feb.	4	4	4	< 1	3	4
March	4	4	4	2	4	2
April	4	6	4	2	4	3
May	3	3	3	3	3	3
June	3	6	3	2	3	3
July	3	2	3	2	3	2
Aug.	5	4	5	6	5	2
Sept.	4	2	4	2	4	2
Oct.	4	4	4	2	4	3
Nov.	4	4	4	2	3	2
Dec.	2	6	2	2	2	4
Total	41		41		38	
Average		4		2		3

Radiation Concentration Guide(1) 3,000 (If $^{125-133}I$, ^{90}Sr and alpha emitters not present)

^3H

Month	No. Samples	Conc.	No. Samples	Conc.	No. Samples	Conc.
Jan.	1	< 1	1	< 1	-	-
Feb.	4	< 1	4	< 1	3	1
March	4	< 1	4	< 1	4	1
April	4	1	4	< 1	4	1
May	3	< 1	3	< 1	3	< 1
June	3	< 1	3	< 1	3	< 1
July	3	< 1	3	< 1	3	< 1
Aug.	5	< 1	5	< 1	5	< 1
Sept.	4	< 1	4	< 1	4	< 1
Oct.	4	< 1	4	< 1	4	1
Nov.	4	1	4	1	3	1
Dec.	2	< 1	2	< 1	2	< 1
Total	41		41		38	
Average		1		< 1		1

Radiation Concentration Guide(1) 3,000

TABLE XV-A

1972 BNL ENVIRONMENTAL MONITORING
SAND FILTER BEDS AND PECONIC RIVER AREA GROUND WATER SURVEILLANCE WELLS
GROSS ALPHA, GROSS BETA, TRITIUM, ^{90}SR AND ^{137}CS AVERAGE CONCENTRATIONS

Well	No.	Gross α (pCi/l or $10^{-9}\mu$Ci/ml)	No.	Gross β (pCi/l or $10^{-9}\mu$Ci/ml)	No.	^{3}H (nCi/l or $10^{-9}\mu$Ci/ml)	No.	^{90}Sr (pCi/l or $10^{-9}\mu$Ci/ml)	No.	^{137}Cs (pCi/l or $10^{-9}\mu$Ci/ml)
SA	3	< 0.5	3	3.4	2	0.25	2	0.2	2	< 0.5
SB	2	< 0.5	2	1.2	1	0.33	1	< 0.2	1	< 0.5
SC	3	< 0.5	3	1.8	1	0.18	1	< 0.2	1	< 0.5
SD	3	< 0.5	3	< 1.0	2	0.28	-	-	-	-
SE	1	< 0.5	1	3.6	1	0.52	-	-	-	-
SG	1	< 0.5	1	2.2	1	0.33	-	-	-	-
SH	1	2.9	1	8.8	1	< 0.50	-	-	-	-
XA	10	< 0.5	10	10.1	10	3.20	1	2.6	1	< 0.5
XB	10	< 0.5	10	4.7	1	0.36	1	< 0.1	1	< 0.5
XC	10	0.3	10	5.0	4	0.93	1	3.1	1	< 0.5
XD	10	< 0.5	10	2.3	2	0.29	1	< 0.1	1	< 0.5
XE	10	0.4	10	4.8	10	3.70	1	0.2	1	< 0.5
XG	10	0.5	10	8.3	10	1.59	1	2.4	1	< 0.5
XH	8	< 0.5	8	2.5	8	< 0.50	1	< 0.1	1	< 0.5
XI	10	< 0.5	10	2.0	1	0.17	1	0.6	1	< 0.5
XJ	10	< 0.5	10	4.6	1	0.21	1	1.4	1	< 0.5
XK	10	< 0.5	10	15.6	10	1.89	1	5.4	1	< 0.5
XL	10	1.4	10	34.4	10	2.46	1	10.0	1	< 0.5
XM	10	< 0.5	10	39.9	10	2.80	1	14.3	1	< 0.5
XO	10	0.4	10	8.7	1	0.24	1	2.6	1	< 0.5
XP	3	< 0.5	3	1.0	3	< 0.50	-	-	-	-
XQ	10	< 0.5	10	6.4	10	2.08	1	0.8	1	< 0.5
XR	7	< 0.5	7	2.7	7	0.54	1	0.4	1	< 0.5
XS	10	0.9	10	12.5	10	0.60	1	2.5	1	< 0.5
XT	10	< 0.5	10	4.6	1	0.23	1	< 0.1	1	< 0.5
XU	10	< 0.5	10	2.5	1	0.36	1	0.7	1	< 0.5
XV*	10	< 0.5	10	40.6	1	0.61	1	0.4	1	< 0.5
XW	10	< 0.5	10	3.3	1	0.31	1	< 0.1	1	< 0.5
XX	4	< 0.5	4	11.2	4	0.85	1	4.0	1	< 0.5
Est. Error at 95% Confidence		± 0.5		± 10% or ± 1		± 10% or ± 0.10		± 10% or ± 0.1		± 0.5
Radiation Concentration Guide(1)		100**		3000***		3,000		300		$2x10^4$

* In the analysis for specific beta- and gamma-emitting nuclides, naturally occurring ^{40}K was found in a concentration of 18.0 pCi/l, more than ten times the normal background found in most other wells.

** If ^{129}I, ^{226}Ra and ^{220}Ra not present.

*** If $^{125-133}$I, ^{90}Sr and alpha-emitters not present.

TABLE XV-B

1972 BNL ENVIRONMENTAL MONITORING
SAND FILTER BEDS AND PECONIC RIVER AREA GROUND WATER
SURVEILLANCE WELLS WATER QUALITY AND PURITY

Well	pH No.	pH Avg.	Conductivity No.	Conductivity Avg. (μmho/cm)	Diss. Oxygen No.	Diss. Oxygen Avg. (ppm)	Nitrate No.	Nitrate Avg. (ppm)	Ammonium Nitrogen No.	Ammonium Nitrogen Avg. (ppm)	Nitrite No.	Nitrite Avg. (ppm)	Phosphate No.	Phosphate Avg. (ppm)	Chromium No.	Chromium Avg. (ppm)	Fluoride No.	Fluoride Avg. (ppm)	Bromine No.	Bromine Avg. (ppm)	Fe No.	Fe Avg. (ppm)
XA	9	6.3	9	174	9	7.3	9	1.8	7	< 0.1	7	0.0	9	0.3	9	0.0	1	0.1	-	-	-	-
XD	9	5.7	9	44	9	8.2	9	0.0	7	0.1	7	0.0	9	0.1	9	0.0	1	0.2	-	-	-	-
XE	9	5.5	9	122	9	7.1	9	0.9	7	< 0.1	7	0.0	9	0.2	9	0.0	-	-	-	-	-	-
XG	3	5.8	3	109	3	5.0	3	0.3	3	1.3	3	< 0.1	3	0.2	3	0.0	-	-	-	-	-	-
XH	4	6.3	4	55	4	9.5	4	0.0	3	0.0	3	0.0	4	0.4	4	0.0	-	-	-	-	-	-
XI	5	5.8	5	51	5	6.8	5	< 0.1	5	< 0.1	5	0.0	5	0.3	5	0.0	4	0.4	3	0.0	-	-
XJ	5	5.7	5	59	5	6.5	5	0.1	5	0.3	5	< 0.1	5	0.2	5	0.0	3	0.0	2	0.0	-	-
XK	5	6.3	5	188	5	5.0	5	0.0	5	1.4	5	0.0	5	0.9	5	< 0.1	2	0.1	2	0.0	1	0.9
XL	3	6.2	3	170	3	10.4	3	0.3	1	1.4	1	0.0	3	0.3	3	0.0	-	-	-	-	-	-
XM	3	6.1	3	180	3	12.0	3	0.9	1	0.0	1	0.0	3	1.0	3	0.0	-	-	-	-	1	0.4
Est. Error		0.3		10		0.5		0.1		0.1		0.1		0.1		0.1		0.1		0.1		0.1
Water Quality Standard (3)		6.5 - 8.5		-		-		20.0		-		-		-		0.1		3.0		-		0.6

TABLE XVI-A

1972 BNL ENVIRONMENTAL MONITORING

SOLID WASTE DISPOSAL AREA, LANDFILL AND DUMP AREA, AND 650 SUMP

GROSS ALPHA, GROSS BETA, TRITIUM, ^{90}SR AND ^{137}CS AVERAGE CONCENTRATIONS

Well	No.	Gross α (pCi/l or $10^{-9}\mu$Ci/ml)	No.	Gross β (pCi/l or $10^{-9}\mu$Ci/ml)	No.	^{3}H (nCi/l or $10^{-9}\mu$Ci/ml)	No.	^{90}Sr (pCi/l or $10^{-9}\mu$Ci/ml)	No.	^{137}Cs (pCi/l or $10^{-9}\mu$Ci/ml)
WB	4	0.5	4	48.0	4	0.83	1	4.2	1	1.7
WC	4	0.4	4	44.3	4	0.58	1	4.3	1	0.3
WD	4	0.4	4	24.3	4	3.15	1	6.0	1	< 0.5
WE	4	< 0.5	4	17.3	4	0.80	1	5.4	2	0.9
WF	2	< 0.5	2	2.7	1	0.75	1	< 0.1	1	< 0.5
WG	2	< 0.5	2	2.4	1	0.42	1	< 0.1	1	< 0.5
WH	2	< 0.5	2	4.9	2	1.75	1	0.6	1	< 0.5
WI	2	< 0.5	2	4.6	2	0.61	1	< 0.1	1	< 0.5
WJ	2	< 0.5	2	9.0	2	0.48	1	0.9	1	< 0.5
WK	4	< 0.5	4	50.8	4	0.89	1	35.2	1	< 0.5
WL	4	< 0.5	4	184.5	4	2.63	1	88.1	1	< 0.5
WM	4	0.9	4	10.5	4	4.33	1	0.3	1	< 0.5
WN	4	< 0.5	4	2.5	4	0.54	1	0.2	1	0.6
WO	4	< 0.5	4	2.2	2	0.39	1	< 0.1	1	< 0.5
WP	4	< 0.5	4	9.4	4	4.32	1	0.9	1	< 0.5
WQ	4	< 0.5	4	7.3	4	2.87	1	< 0.1	1	< 0.5
WR	4	2.7	4	31.8	4	40.55	2	3.1	1	< 0.5
WS	4	< 0.5	4	3.0	4	2.65	1	< 0.1	1	< 0.5
WT	4	0.6	4	1.8	4	0.50	1	< 0.1	1	< 0.5
WU	3	< 0.5	4	2.2	4	0.73	1	< 0.1	1	< 0.5
WV	3	< 0.5	3	1.1	2	0.35	1	< 0.1	1	< 0.5
WW	4	< 0.5	4	2.5	2	0.41	1	< 0.1	1	< 0.5
WX	3	< 0.5	3	2.6	1	0.22	1	< 0.1	1	< 0.5
WZ	3	< 0.5	3	3.1	1	0.76	1	< 0.1	1	< 0.5
W-1	4	< 0.5	4	144.8	4	0.88	1	77.5	1	< 0.5
W-2	3	< 0.5	3	15.0	3	0.96	1	1.8	1	< 0.5
W-3	4	< 0.5	4	5.5	4					
W-4	4	< 0.5	4	4.0	1	0.37	1	0.2	1	< 0.5
W-5	4	< 0.5	4	2.2	2	0.27	1	< 0.1	1	< 0.5
W-6	1	1.9	1	6.8	1	< 0.50	-	-	-	-
1-A	4	< 0.5	4	73.8	1	0.25	1	30.0	1	< 0.5
1-B	4	< 0.5	4	5.4	1	0.33	1	1.2	1	< 0.5
1-C	4	< 0.5	4	3.2	1	0.33	1	0.2	1	< 0.5
1-D	4	< 0.5	4	3.0	1	0.64	1	0.3	1	< 0.5
1-E	4	< 0.5	4	68.3	1	0.49	1	47.0	1	< 0.5
1-F	2	< 0.5	2	1.9	1	0.24	1	< 0.1	1	< 0.5
1-L	1	2.7	1	25.0	1	< 0.50	-	-	-	-
1-M	1	2.9	1	38.3	1	< 0.50	-	-	-	-
1-N	1	0.4	1	3.0	1	< 0.50	-	-	-	-
1-O	1	< 0.5	1	3.4	1	< 0.50	-	-	-	-
1-P	1	1.2	1	7.9	1	< 0.50	-	-	-	-
1-Q	1	2.3	1	18.2	1	< 0.50	-	-	-	-
1-R	1	< 0.5	1	2.8	1	< 0.50	-	-	-	-
Radiation Concentration Guide (1)		100*		3,000**		3,000		300		$2x10^{4}$

* If ^{129}I, ^{226}Ra and ^{220}Ra not present.

** If ^{125}I, ^{133}I, ^{90}Sr and alpha-emitters not present.

TABLE XVI-B

1972 BNL ENVIRONMENTAL MONITORING
SOLID WASTE DISPOSAL AREA, LANDFILL AND DUMP AREA, AND 650 SUMP
SURVEILLANCE WELLS WATER QUALITY AND PURITY

Well	pH		Conductivity (μmho/cm)		Diss. Oxygen (ppm)		Nitrate (ppm)		Ammonium Nitrogen (ppm)		Nitrite (ppm)		Phosphate (ppm)		Chromium (ppm)		Fluoride (ppm)		Bromine (ppm)		Fe (ppm)	
	No.	Avg.	No.	Avg.	No.	Avg.	No.	Avg.	No.	Avg.	No.	Avg.	No.	Avg.	No.	Avg.	No.	Avg.	No.	Avg.	No.	Avg.
WB	1	5.6	1	190	1	4.2	1	0.5	-	-	-	-	1	0.2	1	0.0	-	-	-	-	-	-
WC	1	5.3	1	205	1	9.0	1	1.0	-	-	-	-	1	0.2	1	0.0	-	-	-	-	-	-
WD	1	5.4	1	190	1	10.6	1	0.7	-	-	-	-	1	0.2	1	0.0	-	-	-	-	-	-
WE	1	6.2	1	60	1	9.5	1	0.2	-	-	-	-	1	0.0	1	0.0	-	-	-	-	-	-
1-A	2	6.6	2	100	2	7.9	1	0.4	2	0.6	1	0.0	2	0.3	2	0.0	-	-	-	-	-	-
1-B	2	7.7	2	105	2	9.5	2	0.3	1	0.0	1	0.0	2	0.8	2	0.0	-	-	-	-	-	-
1-C	2	6.8	2	100	2	8.9	1	0.9	2	0.1	1	0.0	2	0.6	2	0.0	-	-	-	-	-	-
Est. Error		0.3		10		0.5		0.1		0.1		0.1		0.1		0.1		0.1		0.1		0.1
Water Quality Standard(3)		6.5 - 8.5		-		-		20.0		-		-		-		0.1		3.0		-		0.6

TABLE XVII

1972 BNL ENVIRONMENTAL MONITORING
CONCENTRATIONS OF ^{90}SR, ^{131}I, ^{137}CS AND K IN MILK

	Farm B - 10 km SSW				Farm C - 10 km SE			
Month	^{90}Sr** (pCi/l or 10^{-9} μCi/ml)	^{131}I (pCi/l or 10^{-9} μCi/ml)	^{137}Cs (pCi/l or 10^{-9} μCi/ml)	K (gm/l)	^{90}Sr** (pCi/l or 10^{-9} μCi/ml)	^{131}I (pCi/l or 10^{-9} μCi/ml)	^{137}Cs (pCi/l or 10^{-9} μCi/ml)	K (gm/l)
Jan.		< 2	15	1.52		3		1.16
Feb.	13	N/A	21	1.40	8	N/A	16	1.25
March								
April			15	1.15			14	1.36
May	8				7			
June								
July		2	11	1.30		< 2	17	1.24
Aug.	7				21			
Sept.								
Oct.		< 2	14	1.22		3	< 5	1.38
Nov.	8				22			
Dec.								
Average	9	< 2	15	1.32	15	2	16	1.28
Est. Error at 95% Confidence	± 1	± 100%	± 5	± 0.20	± 1	± 100%	± 5	± 0.20
Radiation Concentration Guide(1)	200*	100*	$4x10^4$	-	200*	100*	$4x10^4$	

* Based on FRC Radiation Protection Guide(8) Range II upper limit, and an assumed intake of one liter per day.

** Quarterly data of New York State Health Department(6).

TABLE XVIII

1972 BNL ENVIRONMENTAL MONITORING
CONCENTRATIONS OF γ-EMITTING NUCLIDES IN SOIL

Off-Site Location	Month	^{7}Be	^{65}Zn	^{95}Zr-Nb	^{137}Cs	^{144}Ce	U	Th	K (gm/kg)
		(pCi/kg or 10^{-9} μCi/gm)							
Farm A	June	< 500	2,130	643	3,450	2,378	543	893	8.10
3 km NW	Oct.	< 500	432	370	883	2,010	1,500	1,750	9.84
Farm B	June	957	111	690	1,730	973	357	530	4.99
10 km SSW	Oct.	3,300	261	614	2,780	4,240	943	1,750	5.81
Farm C	June	< 500	764	317	2,930	< 500	1,010	1,060	5.32
10 km SE	Oct.	< 500	243	93	621	< 500	904	1,160	5.48
Farm D	June	< 500	393	218	1,320	1,620	1,220	2,070	9.59
15 km NW	Oct.	< 500	366	276	1,020	< 500	1,050	1,110	9.80
Farm H	June	< 500	177	190	2,390	1,720	614	968	5.96
6 km NE	Oct.		191	183	739	1,830	824	1,030	5.09
On-Site Location									
Northwest	May	< 500	260	489	500	2,240	939	1,520	7.01
Perimeter	Sept.		557	372	560	N/A	1,310	1,950	8.23
Southwest	May	< 500	216	92	888	1,060	1,000	1,860	7.21
Perimeter	Sept.		471	< 100	1,170	N/A	1,940	2,190	8.30
Southeast	May	1,030	116	192	363	1,770	1,350	653	8.86
Perimeter	Sept.	< 500	579	< 100	731	< 500	1,530	1,690	10.37
Northeast	May	< 500	253	284	191	1,770	687	1,170	5.90
Perimeter	Sept.		279	244	628	2,940	1,080	1,670	8.00
0.5 km SE HFBR	Nov.	< 500	< 100	253	610	3,220	1,840	1,460	10.22
0.5 km NE HFBR	Nov.	< 500	811	450	2,120	N/A	2,040	2,300	11.26
Waste Dis. Area	Nov.	< 500	842	366	3,210	717	3,280	2,690	12.25
1.5 km NE HFBR	Nov.	< 500	412	< 100	500		1,190	1,050	6.82
Est. Error 95% Conf. Level		± 25	± 50	± 25	± 25	± 25	± 25	± 25	± 25

TABLE XIX

1972 BNL ENVIRONMENTAL MONITORING
CONCENTRATIONS OF γ-EMITTING NUCLIDES IN GRASS

Off-Site Location	Month	^{7}Be	^{65}Zn	$^{95}Zr-Nb$	^{137}Cs	^{144}Ce	K
		(pCi/kg or 10^{-9} μCi/gm)					(gm/kg)
Farm A	June	1,350	< 500	490	50	N/A	6.67
3 km NW	Oct.	1,550	75	68	30	209	5.30
Farm B	June	1,480	< 50	401	81	N/A	5.42
10 km SSW	Oct.	503	< 50	77	139	218	6.10
Farm C	June	688	< 50	243	176	487	4.85
10 km SE	Oct.	607	< 50	42	58	136	4.45
Farm D	June	437	< 50	203	< 50	670	4.59
15 km NW	Oct.	593	< 50	38	< 50	238	6.10
Farm H	June	2,270	< 50	659	183	N/A	4.86
6 km NE	Oct.	1,070	< 50	140	148	398	3.04
On-Site Location							
Northwest Perimeter	May Sept.	1,320	< 50	330	270	N/A	1.94
Southwest	May	1,170	139	455	67	N/A	4.55
Perimeter	Sept.	1,730	238	181	148	N/A	4.77
Southeast	May	1,660	234	706	< 50	N/A	9.35
Perimeter	Sept.	1,880	< 50	492	387	855	2.13
Northeast	May	1,370	164	725	< 50	N/A	8.63
Perimeter	Sept.	2,150	123	487	367	N/A	2.34
0.5 km SE HFBR	Nov.	1,960	260	193	142	N/A	4.68
Solid Waste Disp. Area	Nov.	4,500	305	161	349	N/A	6.48
Est. Error 95% Confidence Level		± 25	± 50	± 25	± 25	± 25	± 25

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